

DIVISION OF AGRICULTURAL ENGINEERING

LIST OF INFORMATION SERIES

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- 3 - Lightning and Protection Against Lightning
- 4 - Electric Light and Power for Farms
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- 6 - Wells - Well Drilling Machinery and Well Appurtenances
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- 12 - Sewage Disposal and Sanitation
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- 14 - History of Development of Farm Machinery
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Magazines and Books on Subject
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U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Void

Information Series - No. 1

December 1915.

DATA ON CEMENT AND CONCRETE

PUBLICATIONS:

The Department of Agriculture Publications, for which prices are given may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. Those indicated as out of print possibly may be consulted in public or institutional libraries.

Department of Agriculture Publications.

**Farmers' Bulletins:**

- No. 403 - "The Construction of Concrete Fence Posts," 1910,  
31 pages, 9 figures. (Out of Print)
- No. 461 - "Small Concrete Structures," 1911, 23 pages, 10 figures  
(Out of Print)
- No. 481 - "Concrete Construction on the Live-stock Farm," 1912,  
32 pages, 24 figures. Price 5¢.

**Department Bulletins:**

- No. 57 - "Water Supply, Plumbing, and Sewage Disposal for Country Homes," 1914, 46 pages, 38 figures, pp 2-5, cisterns; pp 10-13 protective well-linings, curbing or coverings, and springs; pp 38-39, location and construction of septic tanks. (Out of Print)
- No. 126 - "Concrete Linings as applied to Irrigation Canals," (Professional paper) 1914, 86 pages, 17 plates, 15 figures, (Out of Print)
- No. 230 - "Oil-mixed Portland Cement Concrete," 1915, 26 pages 6 plates, 7 figure. Price 10¢.

Department of Commerce Publications

Technologic Papers of the Bureau of Standards No. 3 - "Tests of the Absorptive and Permeable Properties of Portland Cement Mortars and Concretes, Together with Tests of Damp-Proofing and Water-proofing Compounds and Materials," 1911, 127 pages, 53 figures, 25 tables.

Technologic Paper of the Bureau of Standards No. 12 - "Action of the Salts in Alkali Water and Sea Water on Cements," 1913 pp 100 - 102.



U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL MECHANICS

December 1915.

Information Series - No. 1

DATA ON CEMENT AND CONCRETE

Publication No. 1

The Department of Agriculture Publications, for which prices are given may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. These indicated as out of print possibly may be obtained in public or institutional libraries.

Department of Agriculture Publications

Publication No. 1

No. 401 - "The Construction of Concrete Formwork," 1915, 31 pages, 9 figures. (Out of print)

No. 402 - "Small Concrete Structures," 1911, 32 pages, 10 figures (Out of print)

No. 403 - "Concrete Construction on the Live-stock Farm," 1915, 32 pages, 24 figures. Price 24.

Department Publications

No. 404 - "Water Supply, Plumbing and Sewage Disposal for Country Homes," 1915, 46 pages, 25 figures, pp 2-5, tables; pp 10-13 protective wall-tinings, cuttings or coverings, and cuttings; pp 20-32, location and construction of septic tanks. (Out of print)

No. 405 - "Concrete Linings as applied to Irrigation Canals," (Professional paper) 1914, 86 pages, 17 plates, 15 figures, (Out of print)

No. 406 - "Well-constructed Portland Cement Concrete," 1915, 36 pages 6 plates, 7 figures. Price 104.

Department of Commerce Publications

Technical Report of the Bureau of Standards No. 3 - "Tests of the Abrasive and Compressive Properties of Portland Cement Mortars and Concretes, Together with Tests of Pump-Proofing and Water-Proofing Compounds and Mortars," 1911, 137 pages, 23 figures, 22 tables.

Technical Report of the Bureau of Standards No. 13 - "Action of the Salts in Alkali Water and Sea Water on Concrete," 1913, pp 100 - 108.



Department of Interior Publications

- U. S. Geological Survey, "The Cement Industry of the United States in 1913," 1914, pp 117 - 143, 3 figures, tables.
- Bulletin No. 243 - "Cement Materials and Industry of the United States," 1905, 395 pages, 15 plates.
- Bulletin No. 344 - "The Strength of Concrete Beams (results of tests of 108 beams - first series - made at the Structural Materials Testing Laboratories)," 1908, 59 pages, 1 plate.
- Water Supply Paper No. 143 - "Experiments on Steel-concrete Pipes on a Working Scale," 1905, 61 pages, 4 plates.
- Bulletin No. 260, "Contributions to Economic Geology," 1903, 620 pages, 4 plates. Only a small portion of this bulletin is devoted to cement.
- Bulletin No. 522 - "Portland Cement Materials and Industry in the United States," 1913, 401 pages, 19 plates. The first publication of this set, mentioned above, is an extract from this bulletin.
- Bulletin No. 331 - "Portland Cement Mortars and Their Constituent Materials; Results of Tests Made at the Structural Materials Testing Laboratories, Forest Park, St. Louis, Mo., 1905-1907", 1908, 130 pages, 20 plates.
- Mineral Resources of the United States, 1904, 1905, 1906, 1909, 1910, etc. The parts pertaining to cement are but portions of these voluminous reports.

PUBLICATIONS ON CONCRETE ON ALLIED SUBJECTS

Concrete Silo Publications

- Concrete Silo Construction - Bulletin No. 214, University of Wisconsin, Madison, Wisconsin.
- Cement Silos in Michigan - Bulletin No. 255, Michigan State Experiment Stations, East Lansing, Michigan.
- Silage and the Construction of Modern Silos - Bulletin No. 83, Wisconsin Agricultural Experiment Station, Madison, Wisconsin.
- The Silo - Monthly Bulletin No. 2, Volume 6, Missouri State Board of Agriculture, Columbia, Missouri.
- The Reinforced Concrete Silo - Circular No. 49, by the Missouri Agricultural Experiment Station, Columbia, Mo.
- Concrete Silo Construction - Bulletin No. 6, Vol. IV, Kansas State Agricultural College, Manhattan, Kansas.



Publication of Interest Publications

U. S. Geological Survey, "The Cement Industry of the United States in 1911,"  
1912, pp. 117-143, 2 plates, 1 plate.

Bulletin No. 322 - "Cement Materials and Industry of the United States," 1912,  
108 pages, 12 plates.

Bulletin No. 324 - "The Strength of Concrete Beams (Results of Tests of 108  
Beams - First Series - Made at the Structural Materials Testing  
Laboratories)," 1908, 88 pages, 1 plate.

Water Supply Paper No. 108 - "Experiments on Steel-Concrete Pipes on a  
Working Scale," 1908, 61 pages, 4 plates.

Bulletin No. 300, "Contributions to Economic Geology," 1908, 800 pages, 4 plates.  
Only a small portion of this bulletin is devoted to cement.

Bulletin No. 328 - "Portland Cement Materials and Industry in the United States,"  
1912, 401 pages, 12 plates. The first publication of this set,  
mentioned above, is an extract from this bulletin.

Bulletin No. 329 - "Portland Cement Mortars and Their Compressive Strengths;  
Results of Tests Made at the Structural Materials Testing Laboratories,  
Bureau of Reclamation, No. 1, 1908-1907," 1908, 120 pages, 20 plates.

Annual Report of the United States, 1904, 1905, 1906, 1907, 1908, etc.  
The parts pertaining to cement are not portions of these publications  
reports.

PUBLICATIONS ON CONCRETE OR ALIEN SUBJECTS

Concrete and Publications

Concrete and Publications - Bulletin No. 314, University of Wisconsin,  
Madison, Wisconsin.

Cement Silos in Michigan - Bulletin No. 328, Michigan State Experiment  
Station, East Lansing, Michigan.

Silage and the Construction of Modern Silos - Bulletin No. 32, Wisconsin  
Agricultural Experiment Station, Madison, Wisconsin.

The Silo - Monthly Bulletin No. 2, Volume 6, Missouri State Board of Agricul-  
ture, Columbia, Missouri.

The Reinforced Concrete Silo - Circular No. 42, by the Missouri Agricultural  
Experiment Station, Columbia, Mo.

Concrete and Publications - Bulletin No. 6, Vol. IV, Kansas State Agricul-  
tural College, Manhattan, Kansas.



Silos and Silage in Maryland - Bulletin No. 129, Maryland Agricultural Experiment Station, College Park, Maryland.

The Silo and Silage in Indiana - Bulletin No. 40, Purdue Agricultural Experiment Station, Lafayette, Indiana.

Soiling Crops, Silage and Roots - Bulletin No. 9, Series II, College of Agriculture, Cornell University, Ithaca, New York.

Construction of Silos - Bulletin No. 141, Iowa Agricultural Experiment Station, Ames, Iowa.

Construction of Silos - Bulletin No. 138, Nebraska Agricultural Experiment Station .... Nebraska.

Construction of Silos - Bulletin No. 98, North Dakota Agricultural Experiment Station ..... N. D.

Construction of Silos - Bulletin No. 182, Virginia Agricultural Experiment Station, ..... Virginia.

"Modern Silage Methods," published by the Silver Manufacturing Company, of Salep, Ohio.

#### Engineering Experiment Stations.

Iowa State Engineering Experiment Station, Ames, Iowa.

Bulletin No. 30 - "The Determination of Internal Temperature Range in Concrete Arch Bridges."

Bulletin No. 31 - "The Theory of Loads on Pipes in Ditches, and Tests of Cement and Clay Drain Tile and Sewer Pipe".

Bulletin No. 34 - "The Use of Iowa Gravel for Concrete."

Bulletin No. 36 - "Report of the Investigations on Drain Tile of Committee C-6, American Society for Testing Materials," 1914, 112 pages, illustrated.

University of Illinois Engineering Experiment Station, Urbana, Ill.

Bulletin No. 4 - "Tests of Reinforced Concrete Beams," 1905.

Bulletin No. 23 - "Voids, Settlement, and Weight of Crushed Stone", 1908.

Bulletin No. 29 - Tests of Reinforced Concrete Beams; Resistance to Web Stresses", 1909.

Bulletin No. 64 - "Tests of Reinforced Concrete Buildings Under Load", 1913.



Notes and essays in English - Bulletin No. 122, Washington Agricultural  
Experiment Station, College Park, Maryland.

The Role and Place in Nature - Bulletin No. 90, Purdue Agricultural  
Experiment Station, Lafayette, Indiana.

Rolling Excess, Hedges and Holes - Bulletin No. 8, Series II, College of  
Agriculture, Cornell University, Ithaca, New York.

Construction of a Line - Bulletin No. 141, Iowa Agricultural Experiment  
Station, Ames, Iowa.

Construction of a Line - Bulletin No. 128, Nebraska Agricultural Experiment  
Station, Lincoln, Nebraska.

Construction of a Line - Bulletin No. 98, North Dakota Agricultural Experiment  
Station, Grand Forks, North Dakota.

Construction of a Line - Bulletin No. 103, Virginia Agricultural Experiment  
Station, Blacksburg, Virginia.

"Modern Bridge Methods," published by the Silver Spring, Maryland,  
of Bridge, Ohio.

Engineering Experiment Station.

Iowa State Engineering Experiment Station, Ames, Iowa.  
Bulletin No. 30 - "The Determination of Internal Temperature Range  
in Concrete Arch Bridges."

Bulletin No. 31 - "The Theory of Loads on Pipes in Bridges, and  
Tests of Concrete and City Bridge and Street Bridges."

Bulletin No. 34 - "The Use of Load Drives for Concrete."

Bulletin No. 38 - "Report of the Investigation on Bridge Tests at  
Condition C-2, American Society for Testing Materials," 1914,  
112 pages, illustrated.

University of Illinois Engineering Experiment Station, Urbana, Ill.

Bulletin No. 4 - "Tests of Reinforced Concrete Beams," 1905.

Bulletin No. 23 - "Tests, Reinforcement, and Weight of Curved  
Beams," 1908.

Bulletin No. 28 - "Tests of Reinforced Concrete Beams; Workmanship  
and Test Results," 1909.

Bulletin No. 35 - "Tests of Reinforced Concrete Beams Under  
Load," 1911.



Bulletin No. 67 - "Reinforced Concrete Wall Footings and Column Footings," 1913.

Bulletin No. 70 - "The Mortar Making Quality of Illinois Sands," 1913

Bulletin No. 71 - "Tests of Bond Between Concrete and Steel," 1914.

Bulletin No. 81 - "Influence of Temperature on the Strength of Concrete", 1915.

#### Agricultural Experiment Stations.

Arizona State, Tucson, Arizona.

Bulletin No. 55 - "Cement Pipes for Irrigation Ditches," 1907,  
pp 163 - 184.

Report for 1908 - "Construction of Concrete Caissen Wells," pp.373-374.

California State, Berkeley, Cal.

Bulletin No. 198 - "Prevention of Seepage from Canals", pp 365-416,  
15 figures - Ditch Linings.

Colorado, Fort Collins, Colorado.

Bulletin No. 133 - "Cement as Affected by Alkali", 1906, pp 3-8.

Bulletin No. 148 - "Concrete Fence Posts," 1909, pp 3-36, 10 figures.

Bulletin No. 161 - "Concrete Fence Posts," 1910, pp 3-30, 2 figures.

Montana State, Bozeman, Montana.

Bulletin No. 69 - "Cement as Affected by Alkali," 1908, pp 93, 120.

Bulletin No. 81 - "Cement as Affected by Alkali Salts," pp 47-131.

#### ASSOCIATIONS, COMPANIES AND PERIODICALS ADDRESSES AND PUBLICATIONS

Portland Cement Association, 111 W. Washington St., Chicago, Ill.

Kosmos Portland Cement Co., Inc., Paul Jones Bldg., Louisville, Ky.  
"Kosmos Suggestions for Concrete in the Country", 20 pages.

The Atlas Portland Cement Co., 30 Broad St., New York City.  
"Concrete Construction for the Home and Farm," 160 pages.  
"Concrete in Highway Construction", 136 pages.



Bulletin No. 87 - "Unimproved Concrete Well Pockets and Columns  
Footings," 1913.

Bulletin No. 70 - "The water bearing quality of Illinois sands," 1912.

Bulletin No. 71 - "Tests of bond between concrete and steel," 1914.

Bulletin No. 81 - "Influence of temperature on the strength of  
concrete," 1915.

Experimental Research Stations.

Arizona State, Tucson, Arizona.

Bulletin No. 85 - "Recent ideas for irrigation ditches," 1907.  
pp 1-12 - 191.

Report for 1909 - "Construction of concrete Calaca wells," pp. 275-324.

California State, Berkeley, Cal.

Bulletin No. 128 - "Prevention of leakage from canals," pp 1-25-28.  
12 figures - Disc. 14 pages.

Colorado, Fort Collins, Colorado.

Bulletin No. 122 - "Cement as affected by alkali," 1906, pp 1-8.

Bulletin No. 126 - "Concrete fence posts," 1908, pp 1-25, 10 figures.

Bulletin No. 121 - "Concrete fence posts," 1910, pp 1-25, 3 figures.

Montana State, Bozeman, Montana.

Bulletin No. 89 - "Cement as affected by alkali," 1908, pp 25, 1-10.

Bulletin No. 81 - "Cement as affected by alkali," pp 47-121.

ASSOCIATIONS, COMPANIES AND INSTITUTIONS  
ADMINISTRATIVE AND MISCELLANEOUS

Portland Cement Association, 311 W. Washington St., Chicago, Ill.

Kansas Portland Cement Co., Inc., Paul Jones Bldg., Topeka, Kan.  
"Kansas Suggestions for Concrete in the Country," 30 pages.

The Atlas Portland Cement Co., 30 Broad St., New York City.  
"Concrete Reinforced for the Home and Farm," 180 pages.  
"Concrete in Highway Construction," 125 pages.



The General Fire-proofing Co., Youngstown, Ohio.

"The Water-proofing Handbook", 64 pages, illustrated.

The United States Portland Cement Company, Denver, Colo.

Issue small data cards on following subjects: A Partial list of uses for Concrete; Mixing Concrete; Proportioning Concrete; Storing Cement; Bonding New Concrete to Old; Cement Stucco Construction; Concrete Construction; Concrete Silos; The Pit Silo; Concrete Sidewalks and Driveways; Engine Foundations, etc.

Virginia Portland Cement Co., Fordwick, Va.

"What the Farmer can do with Old Dominion Portland Cement."

Universal Portland Cement Co., Chicago, Ill., Pittsburgh, Pa., Minneapolis, Minn.

"Concrete for the Farmer," 1914, 79 pages, illustrated.

"Small Farm Buildings of Concrete," 1914, 158 pages, illustrated.

"Concrete Silos," 1914, 104 pages, illustrated. Contains short bibliography on silos.

"Concrete in the Barnyard," 31 pages, illustrated.

"Standard Specifications for Portland Cement and Uniform Method of Testing and Analysis," 1913, 19 pages, illustrated. Adapted by the American Society for Testing Materials, August 16, 1909.

"Cement Stucco", 1913, 24 pages, illustrated.

"Concrete Surfaces," 1913, 32 pages, illustrated.

"Cement Drain Tile," 1913, 30 pages, illustrated.

"Small Concrete Bridges and Culverts," 1914, 72 pages, illustrated.

"Concrete Highway Bridges," 1913, 38 pages, illustrated.

"Concrete Pavements, Sidewalks, Curb and Gutters, 1913, 96 pages, illustrated.

"Factories and Warehouses of Concrete," 224 pages, illustrated.

"Concrete Chimneys," "Report of an Investigation."

"Concrete Poles," "Comprehensive Discussion."

"Manufacture of Universal Portland Cement."

"Concreting in Cold Weather," "A study of modern equipment."

"Concreting in Cold Weather (Rural Edition)," "A book especially written for the small town contractor and for the farmer doing his own construction."

"Specifications for Construction of One-Course Concrete Street Pavement," 1913, 30 pages, illustrated.

"Proceedings, Conference of Farmers' Institute and Short Course Workers on Permanent and Sanitary Farm Improvements," Chicago, Ill., 1913, 175 pages, illustrated. Papers on many subjects applicable to use of concrete in the country.

"Concrete Roads," published monthly.

"Universal Bulletin", published monthly. Contains articles pertaining to cement and concrete.







"Farm Cement News," A quarterly devoted to the use of concrete on the farm, Vol. 1, No. 6, "Instructions for Concrete Work on the Farm, Concrete Troughs and Tanks"; Vol. 1, No. 8, "Concrete Corner Posts and Fences;" Vol. 1, No. 9, "The Manufacture of Concrete Building Block;" Vol. 1, No.10, "Concrete Walls," etc.

Security Cement and Lime Co., Hagerstown, Md.

"The Effects of Oils on Concrete," 10 pages. "Concrete Pointers No.5." "An abstract of cement technical literature published in the interest of cement users."

Aberthaw Construction Co., Boston, Mass.

"Aberthaw Tests on Concrete in Sea Water" 1914, 36 pages, illustrated

National Concrete Machinery Co., Madison, Wisconsin.

"National Concrete Posts," 6 pages, illustrated. Extract from the Report of the Committee on Signs, Fences, and Crossings of the American Railway Engineering Association.

Angle-IronCement Fence Post Co., Cedar Rapids, Iowa.

D. & A. Post Mold Co., 196 Third Ave., Three Rivers, Michigan.

"Concrete Fence Posts."

"The Toennes Concrete Fence Post," U. S. Patent 931,236 issued August 17, 1909.

#### Periodicals.

"Cement and Engineering News," 672 Transportation Bldg., Chicago, Ill. Monthly.

"Cement Era," The Cement Era Publishing Co., 538 So. Clark St., Chicago, Ill  
"Cement - Concrete - Related Machinery". Monthly.

"Cement World," Cement World Co., 1827 Prairie Ave., Chicago, Ill.  
(345 Fifth Ave., New York). Devoted to the cement engineering and allied industries.

"Concrete - Cement Age," Concrete - Cement Age Publishing Co., Detroit, Mich.  
Devoted to the manufacture and uses of Portland Cement.

"Concrete Era," "Pacific Coast States," Concrete Era Publishing Co., 120 North Broadway, Los Angeles, Cal. (154 W. Randolph St., Chicago, Ill)  
Devoted to the manufacture and uses of cement. Monthly

"The Concrete Age," 502-504 Equitable Bldg., Atlanta, Ga.  
Devoted to modern permanent construction. Monthly.



"State Cement News," a quarterly devoted to the use of concrete on the  
East. Vol. 1, No. 6. "Instructions for Concrete Work on the  
East. Concrete Works and Tenders; Vol. 1, No. 8. "Concrete  
Cement Works and Tenders; Vol. 1, No. 9. "The Manual of  
Concrete Building Blocks; Vol. 1, No. 10. "Concrete Walls," etc.

Security Cement and Glass Co., Hagerstown, Md.

"The Elements of Concrete," 10 pages. "Concrete Reinforcing  
No. 1." An abstract of current technical literature published  
in the interest of current science.

Abrahamson Construction Co., Boston, Mass.

"Abrahamson Works on Concrete in the Water" 1914, 88 pages, illustrated

National Concrete Machinery Co., Madison, Wisconsin.

"National Concrete Works," 8 pages, illustrated. Extract from the  
Report of the Committee on Signs, Symbols, and Drawings of the  
American Railway Engineering Association.

Anglo-American Concrete Works Co., Cedar Rapids, Iowa.

E. & A. Ford Mfg. Co., 106 Third Ave., Three Rivers, Michigan.

"Concrete Works Tools."

"The American Concrete Works Plant," U. S. Patent 221,225 issued August  
17, 1902.

### Periodicals.

"Concrete and Engineering News," 575 Transportation Bldg., Chicago, Ill.  
Monthly.

"Concrete News," The Concrete News Publishing Co., 525 W. State St., Chicago, Ill.  
"Concrete - Concrete - Related Machinery," Monthly.

"Concrete World," Concrete World Co., 1237 Prairie Ave., Chicago, Ill.  
(345 Fifth Ave., New York). Devoted to the concrete engineering and allied  
industries.

"Concrete Age," Concrete Age Publishing Co., Detroit, Mich.  
Devoted to the manufacture and use of Portland Cement.

"Concrete Age," "Concrete Age States," Concrete Age Publishing Co., 120  
North Broadway, Los Angeles, Cal. (125 W. Randolph St., Chicago, Ill.)  
Devoted to the manufacture and use of cement. Monthly.

"The Concrete Age," 525-526 Exchange Bldg., Atlanta, Ga.  
Devoted to concrete permanent construction. Monthly.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

INFORMATION SERIES No. 2 (REVISED)

SEPTEMBER, 1924.

INFORMATION ON WINDMILLS.

PUBLICATIONS:

THE GOVERNMENT PUBLICATIONS, FOR WHICH PRICES ARE GIVEN, MAY BE OBTAINED FROM THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C. THOSE INDICATED AS OUT OF PRINT POSSIBLY MAY BE CONSULTED IN PUBLIC OR INSTITUTIONAL LIBRARIES.

U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

FARMERS' BULLETIN 866, "THE USE OF WINDMILLS IN IRRIGATION IN THE SEMI-ARID WEST." 1917. 5¢.

YEARBOOK SEPARATE 573, "THE WINDS OF THE U. S. AND THEIR ECONOMIC USE." - OUT OF PRINT.

U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C. - WATER SUPPLY PAPERS:

No. 8, "WINDMILLS FOR IRRIGATION." 1897, 49 PAGES. OUT OF PRINT.

No. 20, "EXPERIMENTS WITH WINDMILLS." 1899, 59 PAGES. 15¢.

No. 29, "WELLS AND WINDMILLS IN NEBRASKA", 1899, 85 PAGES. OUT OF PRINT.

No. 41, "THE WINDMILL: ITS EFFECT AND ECONOMICAL USE, PART 1, 1901, 72 PAGES. 5¢.

No. 42, "THE WINDMILL: ITS EFFICIENCY & ECONOMICAL USE, "PART 2, 1901, 75 PAGES. OUT OF PRINT.

U. S. DEPARTMENT OF COMMERCE, WASHINGTON, D. C.

SPECIAL CONSULAR REPORTS, VOL. 31, WINDMILLS IN FOREIGN COUNTRIES. 1904, 293 PAGES, OUT OF PRINT.

"

INQUIRIES IN REGARD TO THESE BULLETINS SHOULD BE ADDRESSED TO THE COLLEGES WHICH PUBLISH THEM.

KANSAS STATE AGRICULTURAL COLLEGE, MANHATTAN, KANSAS.

KANSAS UNIVERSITY QUARTERLY. 6 (1897) #2, PAGES 89-94. REPORTS OF WINDMILL TESTS, BY E. C. MURPHY.

NEBRASKA AGRICULTURAL EXPERIMENT STATION, LINCOLN, NEBR.

BULLETIN No. 59, "HOME-MADE WINDMILLS IN NEBRASKA". 1899, 79 PAGES, 79 FIGURES.

NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION, AGRICULTURAL COLLEGE, N. D. BULLETIN No. 105, "WINDMILL ELECTRIC LIGHTING AND POWER", 1913. 39 PAGES, 21 FIGURES.

WISCONSIN AGRICULTURAL EXPERIMENT STATION, MADISON, WIS.

BULLETIN No. 68, "WINDMILL TESTS". 1899, 44 PAGES, 13 FIGURES.

BULLETIN No. 82, "WINDMILL TESTS". 1900, 37 PAGES, 24 FIGURES.

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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
DIVISION OF APPLICABLE BOTANY

WASHINGTON, D. C.  
JANUARY 10, 1917  
TO THE DIRECTOR, BUREAU OF PLANT INDUSTRY  
FROM THE CHIEF, DIVISION OF APPLICABLE BOTANY

RE: [Illegible text]

1. [Illegible text]

2. [Illegible text]

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4. [Illegible text]

5. [Illegible text]

6. [Illegible text]

7. [Illegible text]

8. [Illegible text]



THE WINDMILL AS A PRIME MOVER, BY ALFRED R. WOLFF, M. E. CONSULTING ENGINEER, AMERICAN SOCIETY OF MECHANICAL ENGINEERS, JOHN WILEY & SONS, NEW YORK - 1900 - 161 PAGES, 40 FIGURES, 17 TABLES 6"x9"

INTRODUCTION. THE USE OF THE WINDMILL.  
CHAPTER I. WIND - ITS VELOCITY AND PRESSURE.  
CHAPTER II. THE IMPULSE OF WIND ON WINDMILL BLADES.  
CHAPTER III THE EARLY HISTORY OF WINDMILLS.  
CHAPTER IV. EUROPEAN WINDMILLS.  
CHAPTER V. AMERICAN WINDMILLS - SIDE VANES - GOVERNOR MILLS.  
CHAPTER VI. " " (CONTINUED)  
CHAPTER VII. AMERICAN WINDMILLS - (CONCLUDED) OTHER TYPES, ETC.  
CHAPTER VIII EXPERIMENTS ON WINDMILLS.  
CHAPTER IX. THE CAPACITY & ECONOMY OF WINDMILLS.  
CHAPTER X. USEFUL DATA IN CONNECTION WITH WINDMILL PRACTICE.

WINDMILLS FOR RAISING WATER, BY JOHN ALFRED GRIFFITHS, B.Sc.

ASSOCIATE MEMBER INSTITUTE CIVIL ENGINEERS, P.P. 321-345.

INCLUSIVE OF VOLUME 119 OF MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS. 1894-05 - PART I - PAPER 2672- (ABSTRACT) GOES INTO THEORY OF THE WINDMILLS AND IN ORDER TO ILLUSTRATE THE METHODS BY WHICH THE PRINCIPLES ARE APPLIED, PARTICULARS ARE GIVEN OF 6 TYPES OF WINDMILLS TO SHOW HOW FAR THE THEORETICAL RESULTS ARE REALIZED IN MODERN PRACTICE.

WINDMILLS AND WIND-MOTORS, BY F. E. POWELL PUBLISHED BY SPON AND CHAMBERLAIN, NEW YORK, 1910; DISCUSSES THE GENERATION OF ELECTRIC ENERGY BY WIND-POWER.

THE FOLLOWING ARTICLES HAVE APPEARED IN THE PUBLICATIONS NOTED:  
THE WINDMILL AS A PRIME MOVER, BY ALFRED R. WOLFF, M. E. CONSULTING TESTS SHOW INCREASED EFFICIENCY IN WINDMILLS PERFORMANCE; BY ALYF. MOHR, AGRICULTURAL ENGINEERING 2:99-101. MAY, 1921. TABLES 6"x9"

INTRODUCTION. THE USE OF THE WINDMILL.  
"PERFORMANCE OF TWO SUCCESSFUL WINDMILL GENERATING OUTFITS" BY FRANK S. CULVER, "ELECTRICAL WORLD" FEB. 24, 1917 (PUBLISHED BY MCGRAW-HILL PUBLISHING CO.) REPORTS TESTS ON PUMPING WITH 12 FOOT WINDMILL AND 12 FOOT POWER MILL BOTH MOUNTED ON 50 FT. TOWERS. TESTS SHOW LITTLE DIFFERENCE IN EFFICIENCY BETWEEN THE TWO. GOVERNOR MILLS  
CHAPTER VI. " " (CONTINUED)

IN THE ELECTRICAL WORLD FEB. 24, 1917 THERE WAS DESCRIBED AN EXPERIMENTAL PLANT WHICH WAS PERECTED ON A FARM IN NORTHERN WISCONSIN. IN THIS PLANT A STORAGE BATTERY OF 26 CELLS HAVING A NORMAL DISCHARGE RATE OF 3 AMPERES FOR 8 HOURS WAS USED. A GENERATOR RATED AT 3 AMPERES, 65 VOLTS, 900 R.P.M. WAS SELECTED FOR DISCHARGING THE BATTERY. AN ORDINARY 12 FT. WINDMILL ON A 50 FT. STEEL TOWER WAS UTILIZED. THE SPEED OF THE MILL WAS STUDIED AND FOUND, DUE TO REGULATING FEATURES, NOT TO EXCEED 75 R.P.M. IN A WIND BLOWING AT THE RATE OF 30 MILES PER HOUR WHEN THE MILL WAS RUNNING WITHOUT LOAD. THE LOW SPEED GENERATOR (900 R.P.M.) ASSURED CHARGING OF THE BATTERY WITH WINDS OF LOW VELOCITY; FOR A SPEED OF 75 R.P.M. THE GENERATOR WAS STEPPED UP TO 1800 R.P.M. SHOW HOW FAR THE THEORETICAL RESULTS ARE REALIZED IN MODERN PRACTICE.

WINDMILLS AND WIND-MOTORS, BY F. E. POWELL PUBLISHED BY SPON AND CHAMBERLAIN, NEW YORK, 1910; DISCUSSES THE GENERATION OF ELECTRIC BY WIND-POWER. 2/4







IN THE "SCIENTIFIC AMERICAN" SEPT. 4, 1915 PUBLISHED BY MUNN & CO. INC. N. Y. C. THERE APPEARED AN ARTICLE ENTITLED "A SMALL AERO-ELECTRIC PLANT" WHICH DESCRIBED THE APPARATUS IN DETAIL WHICH THE AUTHOR STATED SHOULD DEVELOPE 40 TO 60 WATTS OF ELECTRIC POWER WITH A WIND VELOCITY OF 12 TO 14 MILES.

OBSERVED VARIATIONS IN THE VELOCITY OF THE WIND. BY F. HOUDAILLE & DESMOULINS. ANNALS ECOLE NAT. AGR. MONTPELLIER, 10 (1897) P. 48-56. AMOUNT OF THE FORCE OF THE WIND UTILIZED BY WINDMILL IS DISCUSSED.

THE ANNUAL WORK OF A WINDMILL, BY H. D'ANCHALD. JOURNAL AGRICULTURAL PRATIQUE. 1899 11 # 45 P. 677-678.

MOULIN A' VENT A' ROUES ACCOUPLE'ES. JOUR. AGRIC. PRAT. 35:3560 29:21.

LIGHT FROM A WINDMILL. N. D. RAND. COUNTRY GENTLEMAN 83:17 MAR. 30, 1918.

HOMEMADE WINDMILL. COUNTRY GENTLEMAN 85:56 MARCH 6, 1920.

WINDMILL ON THE SILO, BY D. R. VAN HORN. COUNTRY GENTLEMAN. 85:33. NOVEMBER 13, 1920.

WIND AND WATER. BY W. B. JONES, POWER FARMER 28:12-13 N; 50:1-2 DECEMBER 1919.

OUR HOMES, BY A. I. ROOT, GLEANINGS. 51:339-40 MAY, 1923.

WINDMILL WITH COUPLED WHEELS, BY M. RINGELMANN, INTERNATIONAL REVIEW SCIENCE & PRACTICAL AGRICULTURE. 13 NO. 1: 123-4 JANUARY, 1922.

WINDMILL NOTES BY O. P. HOOD. THE INDUSTRIALIST 2 (1895) # 39 P. 157-8. RECORDS POWER EXERTED BY DIFFERENT SIZED MILLS UNDER DIFFERENT WIND VELOCITIES.

MOTIVE POWERS ON THE FARM, BY W. J. MALDEN. TRANS. HIGHLAND & AGRIC. SOC. SCOTLAND. 5 SER 8 (1896) P. 179-213.

COLORADO WIND SUPPLIES ELECTRIC LIGHT, BY R. E. RUGGLES. AMERICAN THRESHERMAN 25:6 AUGUST 1922.

CONVERTING WIND TO ELECTRICITY, BY C. A. CARLISLE, JR., AMERICAN THRESHERMAN 24:8 FEBRUARY 1922.

UTILIZING THE POWER OF AIR AND WATER, BY F. W. IVES. OHIO FARMER, 139:605 APRIL 28, 1917.

WINDMILL FOR FARM POWER, BY C. W. COOPER. NORTHWESTERN FARMER, 41:223 MARCH 6, 1922.

OUR JUNIOR FARMER; PULLING POWER FROM THE AIR. SUCCESSFUL FARMER, 19:54, SEPTEMBER 1920.







INFORMATION SERIES No. 2.

POWER FROM WINDMILLS. FARMERS ADVOCATE. 55:348. FEBRUARY 26, 1920.

TRANSFORMING WIND INTO ELECTRICITY. DAKOTA FARMER, 41:239.  
FEBRUARY 15, 1921.

WIND POWER CANNOT BE TAXED, BY F. M. WHITE. ORANGE JUDD FARMER,  
66:163 FEBRUARY 1, 1919.



Information for use in

Form 100-10 (Rev. 1-25-60) (Instructions for use on page 2)

NAME (Last, first, middle initial) (Print or type) (Do not use initials)  
Address (Street, city, state, and ZIP code)

Who should contact you in case of emergency? (Name and address)  
Date (Month, day, year)



U. S. Department of Agriculture,  
Bureau of Public Roads,  
Division of Rural Engineering.

*Superseded  
by  
713*

Information Series - No. 3

December, 1915.

INFORMATION ON LIGHTNING  
and  
PROTECTION AGAINST LIGHTNING.

Publications:

Lightning and Lightning Conductors, by J. Warren Smith, Prof. of Meteorology, Columbus, Ohio; printed in the "Proceedings and Papers of the Nineteenth Annual Meeting of the National Association of Mutual Insurance Companies," held at Columbus, Ohio, September 22-24, 1914, pp 23-42; Harry P. Cooper, Secretary, Crawfordsville, Ind. This article is also printed as a separate and may probably be obtained upon application to Prof. Smith. Article contains many statistics and also instructions for protecting buildings.

Lightning and Lightning Conductors, by Prof. Alfred J. Henry (1909), U. S. Department of Agriculture Farmers' Bulletin No. 367, 20 pages, illustrated.

Protection of Life and Property against Lightning, by O. S. Peters (1915), U. S. Department of Commerce, Bureau of Standards Technologic Paper No. 56

Protection of Buildings from Lightning, by A. R. Sawyer and L. J. Smith, (Aug. 1907), Michigan State Experiment Station, Agricultural College, Mich.; Bulletin No. 249, 35 pages, illustrated.

The Use of Metal Conductors to Protect Buildings from Lightning, by E. W. Kellogg, Missouri Univ. Engineering Experiment Station, Columbia, Mo. Vol. 3, No. 1.

Lightning Loss and Damage, and Lightning Protection, by Prof. W. H. Day, (March, 1914), Ontario Agricultural College, Toronto, Canada; Bulletin No. 220, Lightning Statistics Gathered in Ontario, Iowa and Michigan.

Preventable Fires, Increasing Farm Hazards due to Modern Conditions, by Chas. E. Campbell; article in the Country Gentleman, March 15, 1913, p 431; Curtis Publishing Co., Philadelphia, Pa.; discusses particularly the lightning risks of barns and the advisability of separating the hay barn from the general barn.

Practical Talks on Farm Engineering; Handbook by R. P. Clarkson; Doubleday, Page & Co., New York; contains short article on the use of barbed wire for lightning rods for protecting farm buildings.

National Board of Fire Underwriters, New York City. The Board furnished suggestions as to the material and installation of lightning rods.



U. S. Department of Agriculture,  
Bureau of Public Roads,  
Division of Road Engineering.

December, 1915.

Information Bulletin - No. 3

PROTECTION ON LIGHTNING  
AND  
PROTECTION AGAINST LIGHTNING.

References:

- Lightning and Lightning Conductors, by J. Weston Smith. First of two parts. Columbia, Ohio: printed in the Proceedings and Papers of the Nineteenth Annual Meeting of the National Association of Mutual Insurance Companies, held at Columbus, Ohio, September 22-24, 1914, pp. 23-42; Henry P. Cooper, Secretary, Cincinnati, Ohio. This article is also printed as a separate and was probably obtained upon application to J. Weston Smith. Article contains many statistics and also instructions for protecting buildings.
- Lightning and Lightning Conductors, by J. Weston Smith. Second of two parts. Department of Agriculture, Bureau of Public Roads, Bulletin No. 207, 20 pages, illustrated, 1915, U. S.
- Protection of Life and Property against Lightning, by C. A. Peters (1915). U. S. Department of Commerce, Bureau of Standards Technologic Paper No. 28.
- Protection of Buildings from Lightning, by A. R. Sawyer and L. J. Smith. (Aug. 1907). Michigan State Experiment Station, Agricultural College, Mich.; Bulletin No. 249, 38 pages, illustrated.
- The Use of Metal Conductors to Protect Buildings from Lightning, by E. W. Kellogg, Assistant Univ. Engineering Experiment Station, Columbia, Mo. Vol. 3, No. 1.
- Lightning loss and damage, and Lightning Protection, by Prof. W. H. Ivy. (March, 1914). Ontario Agricultural College, Toronto, Canada; Bulletin No. 220, Lightning Statistics gathered in Ontario, Iowa and Michigan.
- Preventive Work, Increasing Farm Insurance due to Modern Conditions, by C. W. Campbell; article in the Country Gentleman, March 15, 1915, p. 421; Curtis Publishing Co., Philadelphia, Pa.; addresses particularly the lightning risks of barns and the advisability of separating the hay barn from the general barn.
- Practical Talks on Farm Engineering; Handbook by R. P. Clarkson; Doubleday, Page & Co., New York; contains short articles on the use of buried wire for lightning rods for protecting farm buildings.
- National Board of Fire Underwriters, New York City. The Board furnished suggestions as to the material and installation of lightning rods.



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Old*

U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS.  
DIVISION OF RURAL ENGINEERING.

Information Series -- No. 4 (revised)

June 1916.

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ELECTRIC LIGHT AND POWER FOR FARMS  
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PARTIAL LIST OF PUBLICATIONS:

- Farmers' Bulletin 517, pp. 21-24, inc. Article on Lighting Farm Houses. Compiled from Illinois Sta. Bul. 121, Iowa Sta. Bul. 93, Minnesota Sta. Bul. 126, Missouri Eng. Exp. Sta. Bul. 1, Pennsylvania Sta. Bul. 103, Acetylene gas, gasoline, electricity, and kerosene mantle lamps considered. Obtainable only from Superintendent of Documents, Government Printing Office, Washington, D. C. price 5 cents.
- Illinois Eng. Exp. Station, Urbana, Ill.  
Bulletin 25, Lighting Country Homes by Private Electric Plants (1908)
- Iowa State Eng. Exp. Station, Ames, Iowa.  
Bulletin 25, Electric Power on the Farm, by Adolph Shane.
- Kansas Eng. Exp. Station, Manhattan, Kansas.  
Bulletin 1, Farm Lighting (acetylene, gasoline, electricity)
- Missouri Eng. Exp. Station, Columbia, Mo.  
Bulletin, Vol. 4, No. 1, Economics of Rural Distribution of Electric Power, by L. E. Hildebrand (1913).  
Bulletin, Vol. 16, No. 27, The Economics of Electric Cooking by P. W. Gunder (1915).
- North Dakota College, Government Exp. Sta., Fargo, N.D.  
Bulletin 105, Windmill Electric Lighting and Power, by Wallace Manikowske (1913)
- The Pennsylvania State College, State College, Pa.  
Bulletin Vol. 1, No. 6 (June 1912), Electric Light and Power for Country Homes.

(Note: The above college bulletins may doubtless be secured upon application to the respective colleges)

THE FOLLOWING PUBLISHERS HAVE BOOKS ESPECIALLY PERTAINING TO ELECTRICITY ON THE FARM:

McMillan Co., New York.  
Sturgis & Walton, New York.  
Spon & Chamberlain, New York

Munn & Co., Inc. New York  
The Wm. T. Comstock Co.,  
New York.



IN THE DISTRICT COURT OF THE UNITED STATES  
FOR THE DISTRICT OF COLUMBIA

1917

Case No. 10,000

IN RE: THE ESTATE OF

JOHN W. BROWN

Decedent, by and through his executor,  
JOHN W. BROWN, JR., vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Plaintiffs,  
vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Defendants.

JOHN W. BROWN, JR., Executor,  
vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Plaintiffs,  
vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Defendants.

JOHN W. BROWN, JR., Executor,  
vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Plaintiffs,  
vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Defendants.

THE COURT hereby orders that the  
plaintiffs be and they are

JOHN W. BROWN, JR., Executor,  
vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Plaintiffs,  
vs.  
JOHN W. BROWN, JR., Executor,  
and  
JOHN W. BROWN, JR., Executor,  
Defendants.



SOME RECENT ARTICLES IN FARM JOURNALS RELATING TO USE OF ELECTRICITY  
ON THE FARM:

American Agriculturist, Springfield, Mass.

Oct. 2, 1915, page 6, Dynamo and Milker on Engine.

Jan 22, 1916, page 3, Cheap Electric Current for All.

Country Gentleman:

March 4, 1916, page 19, Electric Light from Water Power  
(illustrated)

Countryside Magazine:

September, 1915, Private Electric Light Plant for Modern  
Country Home.

Dakota Farmer:

March 1, 1916, pp. 294, Electricity on the Farm.

Farm and Fireside, Springfield, Ohio:

May 8, 1915, page 3, Farming by Electricity -- How some  
Farms are using this power with economy -- statistics as  
to uses and cost; by M. G. Franklin.

March 11, 1916, p 10, Farm-made electricity, what small  
home generating plants will do.

Farm and Home, Springfield, Mass.

May 15, 1915, page 14, Washing by Electricity.

Farm Engineering, Chicago, Ill.

July 1915, page 12, Caring for Storage Batteries. Page 4,

Sources of Electrical Energy for Ignition. Page 3,

The Home Electrical (Bungalow at Panama-Pacific Exposition).

Farmer's Guide:

March 4, 1916, page 5, Electricity Makes a Safe Light for  
the Farm Home -- Small Generating Plants Easy to Operate.

May 6, 1916, p 3, Getting five hours of light at a cost of  
one cent.

Farm Implement News, Masonic Temple, Chicago, Ill.

June 24, 1915, p 31, Farm Lighting Plant, Address by Chas. Roth,  
Convention of the National Gas Engine Association.

May 6, 1915, p 42, Power Demanded by Women.

April 29, 1915, p 52, That the Farmers Should Know About Farm  
Lighting Plants, by A. A. Andrews.

April 29, 1915, p 56, Power Washing Machines.

Oct. 14, 1915, p 53, Wisconsin Light Plant.

Nov. 18, 1915, p 42, "Uni-Lectrical" Private Lighting System.

Feb. 10, 1916, p 35, New Small Light Plant, Portable.

March 2, 1916, p 60, 25 light plant for \$100 without engine  
(illus.)

May 11, 1916, p 26, Individual lighting and power plants.

Farm Machinery, March 21, 1916, p 22.

Lighting country homes problem of centuries.

April 13, 1916, p 13, Economics in the use of electricity  
in farming.

April 4, 1916, p 13, New Farm and country home electric  
light plant (United Engine Co.)

May 16, 1916, p 19, Tractor proves acceptable power for  
light plant.







- Farmer and Breeder, Jan. 1, 1916. p 28, Electricity on the Farm.
- Farm, Stock & Home, Minneapolis, Minn.  
May 15, 1915, p 359, Electricity on the Farm, by J. R. Bullard.  
Feb. 15, 1916, p 162, Up-to-date farm lighting (electric, acetylene: Blau gas, alcohol).
- Farmers' Review, Chicago, Ill.  
Sept. 12, 1915, p 6, Fifty Lights at \$1.50 per month.
- Iowa Homestead, Des Moines, Iowa.  
Sept. 2, 1915, p 17, Electric Lighting Systems.  
Nov. 4, 1915, p 6, The Dry Cell (For ignition).
- I & T Trade Journal, May 20, 1916, p 17, Sell engine-generated light to the farmer, by H.R.Brute.
- New England Homestead, 315 Fourth Avenue, New York City.  
Sept. 4, 1915, p 4, Electric Light and Power Plants.  
May 20, 1916, p 26, No more "blue Mondays" now (Laundry apparatus).
- Ohio Farmer:  
March 4, 1916, p 19, Farm Lighting Plant (short article).
- Power Farming, April 1916 p 31, The safe and convenient light, home electric light plant.
- Prairie Farmer, Chicago, Ill.  
July 3, 1915, p 17, Storage Batteries --, Description of the two types, lead-sulphuric acid-lead type and the nickel-iron or Edison type.  
March 25, 1916, p 24, Electricity a great convenience.  
January 29, 1916, p 28, Women tell of Labor Saving Devices.
- Progressive Farmer, Raleigh, N.C.  
Aug. 21, 1915, p 8, Lighting Systems for Farm Homes.  
Page 9, How We Got our Water Works and Electric Lights.
- Rural New-Yorker, New York City:  
May 29, 1915, p 751, Electric Motor for Sewing.
- Threshermen's Review & Power Farming, St. Joseph, Mich:  
Aug. 1915, p 34, Cutting the Rub out of Wash Day.  
Sept. 1915, p 45, Homemade Electric Lighting.  
Nov. 1915, p 18, Electric Light and Power for Farmers.

NAMES OF MANUFACTURERS. -- For these, see their advertisements in current agricultural and engineering periodicals, or in various commercial directories, or address the Society of the American Institute of Electrical Engineers, New York City.







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old  
not up to date*

U. S. Department of Agriculture,  
Office of Public Roads and Rural Engineering,  
Division of Rural Engineering.

Information Series - No. 6.

December, 1915.

INFORMATION ON WELLS, WELL-DRILLING MACHINERY  
AND WELL APPURTENANCES.

Partial List of Publications:

U. S. Department of Agriculture, Washington, D. C.

- (x) Farmers' Bulletin No. 296, "Experiment Station Work, 1907," pp 5-6,  
"Wells and a Pure Water Supply." (Price 5 cents)
- Farmers' Bulletin No. 270, "Modern Conveniences for the Farm Home,"  
Reprint 1915, 48 pages, 26 figures. "Water Supply, Storage and Power  
Available," pp 3-9.
- (x) Farmers' Bulletin No. 549, "Experiment Station Work, 1913" pp 5-9  
"The Farm Water Supply." (Price 5 cents) Compiled from various  
Government and experiment station bulletins.
- (x) B. P.I. Bulletin No. 154, "Farm Water Supplies of Minnesota," 1909,  
87 pages, 4 tables, 73 figures. (Price 15 cents)
- B.P.I. Bulletin No. 212, "A Study of Farm Equipment in Ohio," 1911, 57  
pages, 4 figures, 15 tables, pp 41-42, etc. "Water Supply." Gives  
average costs of wells, pumps, tanks, etc., of various kinds on the  
farms examined.
- (x) Bulletin No. 57, "Water Supply, Plumbing and Sewage Disposal for Country  
Homes," 1914, 46 pages, 38 figures. "Water Supply, Storage, Pumping,  
Distribution, Etc.," pp. 1-30. (Price 10 cents)
- (x) Yearbook Separate No. 634, "Clean Water and How to Get it on the Farm,"  
1915, pp. 139-156, 6 figures, 3 plates. (Price 10 cents)

U. S. Geological Survey, Washington, D. C.

- (x) Fifth Annual Report, Part C. "The Requisite and Qualifying Conditions  
of Artesian Wells." (1883-84) pp. 125-173, 21 plates.

Bulletins:

- (x) No. 158 - "Artesian Well Prospects in the Atlantic Coastal Plain  
Region," 1896, 232 pages, 19 plates.
- No. 264 - "Record of Deep Well Drilling for 1904," 1905, 106 pages.
- (x) No. 298 - "Record of Deep Well Drilling for 1905," 1905, 299 pages

Water Supply Papers:

- No. 57 - "Preliminary List of Deep Borings in the U. S.," Part I  
(Alabama Montana), 1902, 60 pages (see Water Supply Paper 149).
- No. 61 - "Preliminary List of Deep Borings in the U. S.," Part II  
(Nebraska - Wyoming), 1902, 67 pages.
- No. 110 - "Contributions to the Hydrology of Eastern U. S., 1904,"  
1905, 211 pages, 5 plates. Contains articles on the "California"  
or "stovepipe" method of well construction, approximate methods  
of measuring the yield of flowing wells, connections necessary  
in accurate determination of flow from vertical well casings,  
and resources of various sections of the Eastern U. S.

(x) These publications may only be obtained from the Superintendent of Documents,  
Government Printing Office, Washington, D. C. (Stamps not accepted)







- No. 149 - "Preliminary List of Deep Borings in the U. S.," second edition with additions, 1905, 175 pages.
- No. 155 - "Fluctuation of the Water Level in Wells, with Special Reference to Long Island, N. Y.," 1906, 83 pages, 9 plates.
- No. 255 - "Underground Waters for Farm Use," 1910, 58 pages, 17 plates. Besides other information, this publication gives types of wells, methods of boring, etc.
- (x) No. 257 - "Well-Drilling Methods," 1911, 139 pages, 4 plates.
- No. 258 - "Under - "Underground Water Papers, 1910," 1911, 125 pages, 2 plates.
- Various articles on drainage by, freezing of, protection of, pollution of, and magnetic, wells. Also occurrence and composition of well and spring waters, utilization of underground flow, etc.

New Mexico Agricultural Experiment Station, State College, N. M.

Bulletin No. 71 - "Installation of Irrigation Pumping Plant," 1909, pp. 3-75, 18 figures, 4 diagrams. Discusses occurrence of ground waters; sinking of wells, including method, machinery, casings and strainers; types of pumps, engines and motors; and the construction of reservoirs.

Arizona Agricultural Experiment Station, Tucson, Ariz.

Bulletin No. 60 - "Installation of Pumping Plant," 1909, pp. 399-411, 3 figures. Discusses the sinking and curbing of wells, pumps, strainers and power plants.

Kansas Agricultural Experiment Station, Manhattan, Kansas, Bulletin No. 143

California Agricultural Station, Berkeley, Calif., Bulletin "Cost and Installation of Small Pumping Plants."

#### Books on Pumping, Etc:

"Farm Machinery and Farm Motors," by J. B. Davidson and L. W. Chase, 1908, 502 pages, 576 figures; pp. 258-276 on "Pumping Machinery." A simple description of the various kinds of pumps and their adaptation to various kinds of wells.

"Hydraulics and Its Application," by A. H. Gibson, 1908, 757 pages, 310 figures; pp. 546-676 on pumping machinery of various types. This article treats the matter theoretically as well as describing the apparatus.

International Correspondence School Library of Technology.  
Volume on Hydraulics, etc.

"Practical Irrigation and Pumping," by B. P. Fleming, published by McGraw-Hill Book Co., New York.

(x) These publications may only be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. (Stamps not accepted.)







Partial List of Manufacturers:

American Well Works, Aurora, Ill.  
Ajax Iron Works, Corry, Pa.  
Alamo Iron Works, San Antonio, Texas.  
Armstrong-Quam Mfg. Co., Waterloo, Iowa.  
Austin Mfg. Co., Harvey, Ill.  
Boviard & Seyfang Mfg. Co., Bradford, Pa.  
Brockott, C. A., Cement Co., 121 West 8th St., Kansas City, Mo.  
Cyclone Drill Co., Orville, Ohio.  
Dempster Mill Mfg. Co., Beatrice, Neb.  
Everhard Co., Massillon, Ohio.  
Flint-Walling Mfg. Co., Kendallville, Ind.  
Fort Smith Well-Drill Mfg. Co., Fort Smith, Ark.  
Howell, R. R., & Co., Minneapolis, Minn.  
Keystone Drill Co., Beaver Falls, Pa.  
LaCrosse Well Drill Works, LaCrosse, Wis.  
Loomis Machine Co., Tiffin, Ohio.  
Myers, J. E., & Bro., Ashland, Ohio.  
Ingersoll-Rand Co., 11 Broadway, New York  
National Supply Co., Pittsburgh, Pa.  
Cook, A. D., Lawrenceburg, Ind.  
Oil Well Supply Co., 215 Water St., Pittsburgh, Pa.  
Rockford Engine Works, Rockford, Ill.  
St. Louis Well Machine and Tool Co., St. Louis, Mo.  
Sparta Iron Works Co., Sparta, Wis.  
Southern Well Works, Beaumont, Tex.  
Sullivan Machine Co., 42 Broadway, New York.  
Star Drilling Machine Co., Akron, Ohio.  
Titusville Iron Co., Titusville, Pa.  
Western Pipe & Steel Co., Los Angeles, Calif., Furnish stovepipe casings.

Partial List of Pump Manufacturers:

Luitwieler Pumping Engine Co., Rochester, New York.  
Deep well pumping; non-pulsating pumps.  
The American Well Works, Aurora, Ill.  
Centrifugal pumps, volute and turbine.  
Platt Iron Works, Dayton, Ohio.  
Centrifugal pumps.  
National Transit Co., Oil City, Pa.  
Power pumps.  
De Laval Steam Turbine Co., Trenton, N. J.  
Centrifugal pumps.  
The Deming Co., Salom, Ohio.  
Plunger pumps; centrifugal pumps.







DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series - No. 7.

August, 1922.

INFORMATION CONCERNING GARBAGE AND REFUSE DISPOSAL

PARTIAL LIST OF COMPANIES SUPPLYING INCINERATORS AND EQUIPMENT.

Morse-Boulger Destructor Co., 39 Cortlandt St., New York City.  
Nine to 40 tons in 24 hours (garbage and refuse).  
Kutztown Foundry and Machine Co., Kutztown, Pa.  
Large size for cities of 75,000 and upwards (garbage, saves by-products).  
The C. O. Bartlett & Snow Co., Cleveland, Ohio.  
"Cobwell" system, eight tons of garbage per day upward.  
Nye Odorless Crematory Co., Macon, Ga.  
Built in units each to accommodate about 15,000 people (garbage).  
The Harris Municipal Garbage Incinerator and Steam Generator Co.,  
Nashville, Tenn.  
Ten to 250 tons in single units; multi-unit in any size.  
"Burn All" Garbage Incinerator (G. A. Overson, Patentee), International  
Falls, Minn.  
Built in units of 5 tons in 24 hours, which is approximately the  
product of a city of 5,000 inhabitants.  
Stacy-Bates Co., 815 McKnight Building, Minneapolis, Minn.  
"Decarie" incinerators. (garbage and refuse).  
Power Specialty Co., 111 Broadway, New York City.  
The "Heenan" refuse destructor, 24 tons, 50 tons and up.  
The Griscom-Russell Co., 90 West St., New York City.  
Thirty tons and up. (refuse and garbage)  
Lewis and Capron Co., 910 S. Michigan Ave., Chicago, Ill.  
Large size, 2 tons per hour. (garbage)  
American By-Product Machinery Co., 90 West St., N. Y. City.  
American Process Co., 68 William St., N. Y. City.  
American Reduction Co., 1942 Forbes St., Pittsburgh, Pa.  
United States Incinerator Co., Buffalo, N. Y.  
Manitowoc Engineering Works, Manitowoc, Wis.  
Jeffrey Mfg. Co., Columbus, Ohio.  
Garbage handling machinery.  
Buffalo Engine Co., Buffalo, N. Y.  
Garbage handling machinery.  
Buckeye Boiler Co., Dayton, Ohio. )  
McDermott Bros., Co., Allentown, Pa. )  
Sims Co., 18th & Whitley Ave., Erie, Pa. )  
Troy Wagon Works Co., Troy, Ohio. )  
Studebaker Corp., South Bend, Ind. ) --- Garbage tank & wagons.  
Watson Wagon Co., Canastota, N. Y. )  
George H. Holzbog & Brother, Jeffersonville, Ind. )  
Tiffin Wagon Co., Tiffin, Ohio. )  
Glen Wagon & Car Corp., Cortland, N. Y. )







Kerner Incinerator Co., Milwaukee, Wis.

Chimney incinerators for residences, office and factory buildings, etc.; up to 70 or 80 bushels of mixed household waste, consisting of waste paper, garbage, rags, sweepings, tin cans, etc.

J. B. Prescott & Son, Webster, Mass.

"Pyrofuse", portable and wall types, for households, hospitals, and institutions; size, 1/2 to 4 bushels.

The Nightingale Co., 103 Park Ave., New York City.

"Ricketts" incinerators, portable and wall types.

United States Incinerator Co., Buffalo, N. Y.

Sizes up to 8 bushels per charge, portable and wall types, garbage, refuse and excrement destructors for hospitals, camps, residences, etc.

The Stacy-Bates Co., 815 McKnight Building, Minneapolis, Minn.

E. C. Stearns & Co., 450 Oneida St., Syracuse, N. Y.

(incinerator for excrements also)

Kewanee Boiler Company, Kewanee, Ill.

The Morse-Boulger Destructor Co., 39 Cortlandt St., New York City.

Sims Company, 18th and Whitley Ave., Erie, Pa.

Domestic Laundry Equipment Corp. 228 W. 26th St., N. Y. City.

Illinois Malleable Iron Co., 1801 Diversey Boulevard, Chicago, Ill.

MacLeod Company, 2227 Bogen St., Cincinnati, Ohio.

(incinerators for excrements also).

McCall Incinerator Co., Memphis, Tenn.

(incinerator for excrements also).

Herbert Boiler Co., 140 Root St., Chicago, Ill.

Andrews Heating Co., Minneapolis, Minn.

Frank Prox Co., Terra Haute, Ind.

M. J. Cragin, 745 E. 43rd St., Chicago, Ill.

Griscom-Russell Co., 90 West St., N. Y. City.

While the above firms are believed to be reliable, the Department's endorsement of either the price or the quality of their products is not to be implied.

#### FEW CITIES WHERE INCINERATORS OR DESTRUCTORS HAVE BEEN INSTALLED WITH APPROXIMATE 1910 POPULATION.

Easton, Pa., 26,000.

Los Angeles, Calif. 320,000. (feed about 3,500 hogs).

Panama-Pacific Exposition, San Francisco (8 to 12 tons per day).

New Bedford, Mass. 97,000 (30 tons per day).

Macon (40,000), Waycross (15,000) and Albany (8,000), Georgia.

Pensacola (23,000), St. Petersburg (4,000), and Key West (20,000), Fla.

Florence (7,000) S. Car., (10-ton plant).

Greenville (16,000), Spartansburg (18,000), and Lake City (1,000), S. C.

Raleigh (19,000), Durham (18,000), Greensboro (16,000), Winston-Salem, (23,000), and Goldsboro (6,000), N. Car.

Norfolk (68,000), and Berkley (5,000), Va.







Baton Rouge, La.  
 Tuscaloosa, Ala. (9,000).  
 Columbus, Miss. (9,000).  
 Roanoke, Va. (35,000), (50 tons, Decarie type).  
 Petersburg, Va. (24,000), (25, tons).  
 International Falls (4,000), Burdett, and Spooner (700), Minn.  
 Grand Forks, N. Dak. (13,000).  
 Fort Frances, Ontario (1,600).  
 Berkeley, California (40,000), (40 tons of mixed refuse).  
 Columbus, Ohio (182,000) (30 tons of mixed refuse and garbage).  
 Huntington, W. Va., (31,000), (2 tons of wet garbage per hour).

Data gathered by the Garbage Utilization Division during the war on the practices in 693 cities is summarized in the Engineering News-Record for October 17, 1918. This data indicates that 37 cities having a population of 18,554,000 have reduction or rendering works; 345 cities having a population of 11,180,000 were feeding to hogs; 102 cities having a population of 7,032,000 have incinerators; and 214 cities having a population of 6,928,000 buried or dumped their garbage and burned paper and rubbish in the open.

#### PUBLICATIONS AND ARTICLES ON THE SUBJECT:

- "Government Publications Relating to Health, Disease, and Sanitation".  
 For sale by the Superintendent of Documents, Washington, D. C.  
 Price list No. 51, July, 1914, sent free.
- General Statistics of cities, 1909. Including Statistics of Sewers and Sewerage Disposal, Refuse Collection and Disposal, Street Cleaning, Dust Prevention, Highways, and the General Highway Service of Cities having a Population of over 30,000". Bureau of the Census, Dept. of Commerce, Washington, D. C. 197 pages, 9 $\frac{1}{2}$ " x 12".
- Municipal Ordinances, Rules, and Regulations Pertaining to Public Health, Adopted July 1 to Dec. 31, 1911, by Cities of the United States Having a Population of over 10,000 in 1910". From Public Health Reports, Vol. 27, Nos. 4-40, 226 pages, price 15. Obtainable from the Superintendent of Documents, Washington, D. C.
- "Organization, Power, and Duties of Health Authorities. Analysis of Laws and Regulations Relating Thereto in Force in United States, 1912." Public Health Bulletin 54, 452 pages, price 25 cents. Obtainable from the Superintendent of Documents, Washington, D. C.
- "Manual of Military Hygiene", by Valery Havard. Contains short descriptions of various types of incinerators.
- "Collection and Disposal of Municipal Refuse", by Rudolph Herring and Samuel A. Greeley, Consulting Engineers, 653 pages, 6" x 9", May, 1921, price \$7.00, published by McGraw-Hill Book Co., Inc., 370-7th Ave., N. Y. City (a comprehensive treatment of modern theory and practice).







The articles listed below reflect a variety of viewpoints regarding incinerators and garbage and refuse disposal:

Published in Engineering News,  
10th Ave., at 36th St., N. Y. City.

| Article                                                                         | Date            |
|---------------------------------------------------------------------------------|-----------------|
| New Garbage and Refuse Incinerators for San Francisco.                          | Feb. 15, 1914.  |
| Garbage and Refuse Disposal and Experiences with Incinerators at San Francisco. | Feb. 15, 1915.  |
| Municipal Refuse Sorting and Utilization Plant, Pittsburgh, Pa.                 | Apr. 30, 1914.  |
| Collection and Disposal of City Refuse, Washington, D. C.                       | Oct. 1, 1914.   |
| All-Steel Refuse Incinerator, Roanoke, Va. ("Decarie" type, 50 tons.)           | Apr. 8, 1915.   |
| Municipal Garbage Reduction Plant, Schenectady, N. Y.                           | Apr. 29, 1915.  |
| Refuse Incinerator, Florence, S. C. (12-ton, Population 7000).                  | June 17, 1915.  |
| Operating Results of the Palo Alto Refuse Incinerator.                          | Dec. 9, 1915.   |
| Analytical Study of Garbage, Rubbish and Ashes.                                 | Aug. 17, 1916.  |
| Some Results of Analyses of Garbage and Waste.                                  | Aug. 24, 1916.  |
| Large Mill-Refuse Burner Built of Concrete and Brick.                           | Sept. 28, 1916. |
| Garbage and Rubbish Disposal in Los Angeles, Calif.                             | Oct. 12, 1916.  |
| Garbage Disposal for Two Illinois Cities.                                       | Oct. 12, 1916.  |

Published in Engineering News-Record,  
10th Ave., at 36th St., N.Y. City.

|                                                                                                   |                   |
|---------------------------------------------------------------------------------------------------|-------------------|
| What a City Planning a Garbage Piggery Should Know.                                               | Apr. 26, 1917.    |
| Extracting Alcohol from Garbage would conserve Vast Quantities of Grain and Potatoes.             | June 14, 1917.    |
| Worcester Owns and Operates a Model Garbage Disposal Piggery.                                     | Aug. 30, 1917.    |
| Camp Wastes Yield Large Revenue to the Government (Contracting firm at each cantonment is given). | Oct. 18, 1917.    |
| Effects of the War on Garbage Production and Disposal                                             | Oct. 25, 1917.    |
| New Piggery in Topeka Utilizes Garbage.                                                           | Nov. 8, 1917.     |
| Columbus Makes Money from Garbage Reduction Works.                                                | Nov. 29, 1917.    |
| Quantity and Quality of Garbage Lowered by War conditions (Boston)                                | Dec. 13, 1917.    |
| Confer on Garbage Piggeries at Chicago (sanitary and economic phases).                            | Dec. 27, 1917.    |
| Burning Coal to Consume Garbage.                                                                  | Feb. 28, 1918.    |
| Improved Waste Collection and Disposal Recommended.                                               | Mar. 14, 1918.    |
| N. Y. City has the Largest and Best Garbage Reduction Works.                                      | Mar. 21, 1918.    |
| Wichita Shares Profits from Feeding Garbage to Hogs.                                              | June 20, 1918.    |
| Altoona Makes Pork of Garbage Instead of Fire.                                                    | June 20, 1918.    |
| Army Leads in Waste Prevention and Utilization.                                                   | July 4, 1918.     |
| Declares Garbage Reduction Works a Nuisance.                                                      | Aug. 8, 1918.     |
| New Contracts Let for Camp Garbage and Manure.                                                    | Aug. 29, 1918.    |
| War's Influence on the Garbage Pail.                                                              | Feb. 20, 1919.    |
| Experiences in Garbage Collection and Disposal at Akron, Ohio.                                    | Dec. 11-18, 1919. |







| Article                                                                                                                                                                                           | Publication                                                                                                     | Date                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------|
| The Disposal of Municipal Refuse.                                                                                                                                                                 | Journal of the Association of Engineering Societies,<br>715 Tremont Temple, Boston, Mass.                       | Oct. 1904.                   |
| Refuse Incinerator at Petersburg, Va.<br>("Decarie" type, 25 tons, official test).                                                                                                                | Municipal Journal, Now Public Works,<br>243 West 39th St., N. Y. City.                                          | Mar. 11, 1915.               |
| Using City Waste.<br>How Garbage is made into Fertilizer (describes Los Angeles Reduction Plant).                                                                                                 | Farm and Fireside,<br>202 West High St.,<br>Springfield, Ohio.                                                  | Aug. 14, 1915.               |
| Refuse Disposal in Southern Cities with Particular Reference to Savannah, Ga., and its Incinerator, by E. R. Conant, City Engineer. Gives table showing method of disposal in 39 southern cities, | American Journal of Public Health,<br>370-7th Ave., N. Y. City.                                                 | Sept., 1915.                 |
| Modern Method of Garbage Disposal in Cities and Villages.                                                                                                                                         | "Public Health", State Board of Health,<br>Lansing, Michigan.                                                   | Dec., 1915.                  |
| The Fertilizer Value of City Waste. (1) The Composition of Garbage. Methods of Garbage Utilization, Recovery of Grease and Tankage.                                                               | Journal of Industrial and Engineering Chemistry, American Chemical Society, 35 East 41st St.,<br>New York City. | Jan. 1, 1917,<br>July, 1918. |
| Refuse Incineration, Wilmington, Del. (discusses wrapping, dumps, reduction, etc.).                                                                                                               | Public Works,<br>243 West 39th St.,<br>N. Y. City.                                                              | Oct. 22, 1921.               |
| Six Types of Construction Camp Garbage and Refuse Incinerators.                                                                                                                                   | Engineering and Contracting,<br>9 South Clinton St.,<br>Chicago, Ill.                                           | Sept. 1, 1915.               |
| Refuse Disposal in Small Cities and Towns. (a good resume of present practices).                                                                                                                  |                                                                                                                 | Feb. 8, 1922.                |







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

INFORMATION SERIES -- No. 8.

JANUARY, 1916.

INFORMATION ON WATER POWER, RESERVOIRS, ETC.

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- OFFICE OF EXPERIMENT STATIONS BULLETIN 146, "CURRENT WHEELS: THEIR USE IN LIFTING WATER FOR IRRIGATION." 1904, 38 PAGES, 21 FIGS. 4 PLATES. MANY TYPES OF HOMEMADE UNDERSHOT WHEELS ARE DESCRIBED AND ILLUSTRATED. 5¢
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- OFFICE OF EXPERIMENT STATIONS BULLETIN 249, PART I, "EARTH-FILL DAMS AND HYDRAULIC-FILL DAMS," 41 FIGS., 20 PLATES. 95 PAGES. 1912.
- OFFICE OF EXPERIMENT STATIONS BULLETIN 249, PART II, "TIMBER DAMS AND ROCK-FILL DAMS," 1912, 64 PAGES, 38 FIGS., 7 PLATES. OUT OF PRINT.
- FARMERS' BULLETIN 394, "WINDMILLS IN THE SEMI-ARID WEST," 1910, 44 PAGES, 15 FIGS. OUT OF PRINT.
- FARMERS' BULLETIN 828, "FARM RESERVOIRS", 1910, 36 PAGES, 31 FIGS. 5¢.

OTHER PUBLICATIONS:

- HYDRAULIC AND EXCAVATION TABLES, BY THE U. S. RECLAMATION SERVICE, DEPARTMENT OF THE INTERIOR, 117 PAGES, 1913. CLOTH \$1.25; PAPER \$1.00.
- WATER SUPPLY PAPERS. APPLY TO U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C. FOR LIST.
- WATER POWER FOR THE FARM AND COUNTRY HOME, BY DAVID R. COOPER, 1911, 45 PAGES, ILLUSTRATED. PAMPHLET PUBLISHED BY THE STATE WATER SUPPLY COMMISSION, NEW YORK. COPIES MAY BE AVAILABLE. APPLY TO THE CONSERVATION COMMISSION, ALBANY, N. Y.
- SMALL WATER POWERS IN TENNESSEE, 1910. TENNESSEE STATE GEOLOGICAL SURVEY, NASHVILLE, TENNESSEE.
- ELECTRICITY ON THE FARM, BY F. I. ANDERSON, 1915, 265 PAGES, ILLUSTRATED. PUBLISHED BY THE MACMILLAN CO., NEW YORK. PART I, PP. 1-85, "WATER POWER."

PARTIAL LIST OF TEXT BOOKS:

- WATER POWER ENGINEERING, BY D. W. MEADE; MCGRAW-HILL BOOK CO., NEW YORK, 1916, 843 PAGES, FULLY ILLUSTRATED.
- HYDRAULICS AND ITS APPLICATIONS, BY A. M. GIBSON, 1908; D. VANNOSTRAND CO., NEW YORK, 757 PAGES, FULLY ILLUSTRATED.
- HYDRAULIC MOTORS, BY I. P. CHURCH, 1908; JOHN WILEY & SONS, NEW YORK. 269 PAGES AND APPENDIX, FULLY ILLUSTRATED.







PARTIAL LIST OF TEXT BOOKS (CONT'D):

- RIVER DISCHARGE, BY J. C. HOYT AND N. C. GROVER; JOHN WILEY & SONS, NEW YORK, 1915, 183 PAGES, ILLUSTRATED.  
TREATISE ON HYDRAULICS, BY MANSFIELD MERRIMAN; JOHN WILEY & SONS, NEW YORK, 1915, 565 PAGES, ILLUSTRATED.  
HYDRAULIC TURBINES, BY GELPKE AND VANCLEVE; MCGRAW-HILL BOOK Co., NEW YORK, 1916, 300 PAGES, ILLUSTRATED.

PUBLISHED ARTICLES:

- POWER OF STREAM, IOWA HOMESTEAD, 8-9-15, P. 13.  
A DAM ACROSS THE GULLY (IRRIGATION), FARM ENGINEERING, OCT. 1915, P. 66  
WATER POWER PROBLEMS (ANSWER TO QUERY), FARM ENGINEER, OCTOBER 1915, P. 69.  
PHOTO OF SMALL WATER POWER PLANT, NATL. STOCKMAN AND FARMER, OCTOBER 9, 1915, P. 5.  
WATER AT WORK, COUNTRY GENTLEMAN, APRIL 3, 1915, P. 650.  
POWER PLANT, PROGRESSIVE FARMER, JAN.-JUNE, 1915, P. 115.  
WHY SO MUCH LOST POWER? NEW ENGLAND HOMESTEAD, OCTOBER 23, 1915, P. 15.  
POWER FROM SMALL STREAM (QUERY), OHIO FARMER, OCTOBER 30, 1915, P. 3

MANUFACTURERS, ETC. OF WATER WHEELS, TURBINES AND APPLIANCES:

- FITZ WATER WHEEL CO., HANOVER, PA., MANUFACTURE THE "ALL STEEL OVERSHOOT WATER WHEEL," PIPING, ETC.  
JAMES LEFFEL & CO., 302 LAGONDA ST., SPRINGFIELD, OHIO, MANUFACTURE TURBINES AND ALL APPLIANCES.  
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U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

Information Series - No. 9. (Revised)

November 1919.

INFORMATION CONCERNING TRACTORS - DYNAMOMETER TESTS,  
AND GASOLINE ENGINES.

STATE AGRICULTURAL EXPERIMENT STATION PUBLICATIONS.

Note: - It is not probable that many of the following State Experiment Station bulletins are now available, therefore brief abstracts (from the Experiment Station Index) are here given.

Iowa Agricultural Experiment Station, Ames, Iowa.

Iowa Biennial Report for 1907-8, pp. 190 -197 (E.S.R., Vol. 21, p. 392), "Wagon Draft and Axle Friction," by J. B. Davidson. "An account is given of dynamometer tests to determine the draft of wagons according to kind of road surface and size of wheels and tire, with the amount of net load under different conditions of the surface as to firmness, dryness, and frost. Tests were also made to determine the relative advantages of different types of wagon axles and bearings and the effectiveness of lubricants. The results are considered inconclusive as regards the different brands."

Michigan Agricultural Experiment Station, East Lansing, Michigan.

Michigan Report for 1896, p. 110 (E.S.R., Vol. 10, p. 195), "Farm Wagons, Dynamometer Tests of Draft," by A. A. Crozier. "On good roads the drafts of wide and narrow tired wagons were about equal. On plowed land a narrow-tired wagon pulled 45 per cent harder than one with wide tires; on a road with sand two inches deep, 25 per cent harder, and on sod, 16 per cent harder. A wagon not greased pulled 18 per cent harder than when greased." Bulletin 165, December, 1898, pp. 97-100 (E.S.R., Vol. 11, p. 96), "Farm Implements, Dynamometer Tests of Draft," by M. W. Fulton. "Tests were made of wagons, subsoilers, harrows, and mowers. The difference in draft of wagons with wide (4 inches) tires and wagons with narrow (1-5/8 inches) tires ranges from 6.62 per cent on a gravel road to 32.83 per cent on corn stubble in favor of the wide tires. Tests were made to study the influence of the position of the load on the wagon upon the draft, the influence of point of attachment of the power upon the draft, and the reduction of draft due to greasing the axles. Comparative tests were made of 2 subsoil plows of different make, a floating and a riding spring-tooth harrow, and 2 mowers. Reprinted in the report of the station for 1899, p. 193."

Missouri Agricultural Experiment Station, Columbia, Missouri.

Bulletin 4, 1888, pp. 24, diag. 9. "Tillage Implements, Dynamometer Tests of Draft," by J. W. Sanborn. "Notes and tabulated data for tests of 6 kinds of harrows and 3 of cultivators with reference to draft, depth of cultivation, draft per inch and pound of soil stirred, and pulverization of soil."

Bulletin 32, January, 1888, pp. 19, figs. 6. "Plows, Dynamometer Tests of Drafts," by J. W. Sanborn. "After a brief introduction concerning plows and plowing in general, observations are reported on the draft of plows as affected by method of harnessing, use of wheel or truck and coulters,



November 1919

Publication Series - No. 9 (Revised)

INFORMATION CONCERNING TRACTORS - EXPERIMENTAL TESTS

AND GASOLINE ENGINES

IN AGRICULTURAL EXPERIMENT STATION PUBLICATIONS

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Iowa Agricultural Experiment Station, Ames, Iowa.  
Iowa Biennial Report for 1907-8, pp. 190-197 (E.S.R., Vol. 21, p. 192).  
"Wagon Draft and Axis Rotation," by J. A. Davidson, "An account is given of dynamometer tests to determine the draft of wagons according to kind of road surface and size of wheels and axle, with the amount of net load under different conditions of the surface as to firmness, roughness, and frost. Tests were also made to determine the relative advantages of different types of wagon axles and bearings and the effectiveness of lubricants. The results are considered in connection with the different brands."

Michigan Agricultural Experiment Station, East Lansing, Michigan.  
Michigan Report for 1908, p. 140 (E.S.R., Vol. 10, p. 122). "Wagon Wagons."  
Dynamometer Tests of Draft, by J. A. Davidson, "On good roads the draft of wide and narrow lined wagons were about equal. On heavy land a narrow lined wagon pulled 45 per cent harder than one with wide tires on a road with sand two inches deep. 25 per cent harder, and on sand, 15 per cent harder. A wagon not pressed pulled 18 per cent harder than when pressed."

Pullman 1909, September, 1898, pp. 97-100 (E.S.R., Vol. 11, p. 92). "Farm Wagons."  
Dynamometer Tests of Draft, by W. W. Fulton, "Tests were made of wagons, road rollers, harrows, and mowers. The difference in draft of wagons with wide (tires) tires and wagons with narrow (1.5-1.8 inches) tires ranges from 6.0 per cent on a gravel road to 32.3 per cent on corn stubble in favor of the wide tires. Tests were made to apply the influence of the position of the load on the wagon upon the draft, the influence of point of attachment of the power upon the draft, and the reduction of draft due to greasing the axles. Representative tests were made of 2 wheel and 4 wheel different makes, a floating and a riding spring wheel harrow, and 2 mowers. Reported in the report of the station for 1909, p. 122."

Missouri Agricultural Experiment Station, Columbia, Missouri.  
Bulletin 1, 1898, pp. 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.



and width and depth of furrow. Various practical conclusions are drawn from the results."

New Hampshire Agricultural Experiment Station, Durham, New Hampshire.

Report for 1888, p. 94. "Mowing Machines, Dynamometer Tests of Drafts," by G. H. Whitcher. "Brief reference to a test of 2 machines."

Bulletin 87, November 1901, pp. 122-124 (E.S.R. Vol. 14, p. 196). "Farm Implements, Dynamometer Tests," by C. W. Burkett and F. S. Johnston. "Tests of draft of old and modern types of walking plows, disk and spring-tooth harrows, corn binders, and farm vehicles (wagons, carts, and sleds) under different conditions are briefly reported."

South Carolina Agricultural Experiment Station, Clemson College, S. C.

Bulletin 48, December, 1899, pp. 16 (E.S.R. Vol. 12, p. 196). "Wagons, Broad Vs. Narrow Tires," by C. M. Connor. "An account is given of two dynamometer tests on wet and dry sandy roads of wagons having tires 6 inches and  $1\frac{1}{2}$  inches wide, with a summary of similar tests at other stations. 'In all conditions of sand roads the draft of the broad tire was from 7.49 to 28.6 per cent less than that of the narrow tire. There was little difference in the draft of the broad tire on wet or dry sand. The narrow tire pulls a little more than 5 per cent lighter in wet sand. The condition of the road was not improved by the use of the broad tire except for broad tires. The draft of the narrow tire was 5.73 per cent less in loose sand than in a well-formed rut of the broad tire.'"

Utah Agricultural Experiment Station, Logan, Utah.

Bulletin 2, November, 1890, pp. 13 (E.S.R. Vol. 2, p. 376). "Plows, Test of Draft," by J. W. Sanborn, "Brief accounts of experiments by the author and A. A. Mills in which the draft of plows used under different conditions was determined with the dynamometer. The following points were investigated; The effect of (1) the coulter, (2) the small wheel under the beam, (3) lengthening the hitch, (4) varying the plowman, (5) sharpened vs. new points, (6) sharp vs. dull points, (7) adjustment of plow, (8) angle of the plow point (9) walking vs. sulky plows, and (10) varying width and depth".

Bulletin 4, January, 1891, pp. 21 (E.S.R. Vol. 2 p. 515). "Wagons, Dynamometer Tests," by J. W. Sanborn. "Accounts of tests with reference to the draft of wagons as affected by the distribution of the load, height of wheel, length of hitch, loose vs. tight burs, lubricants, construction of wagon, kind and grade of road."

Bulletin 6, May, 1891, pp. 14 (E.S.R. Vol. 3, p. 100). "Sleds and Harrows, Dynamometer Tests," by J. W. Sanborn. "Accounts of tests of the draft of sleds as affected by the method of attaching the horse and of loading, and by different styles of shafts; and of different kinds of harrows."

Bulletin 7, July, 1891, pp. 19 (E.S.R. Vol. 3, p. 179). "Mowing Machines, Dynamometer Tests," by J. W. Sanborn. "Accounts of tests of draft of several different kinds of mowing machines, in cutting grass, clover, and alfalfa under varying adjustments."

Wisconsin Agricultural Experiment Station, Madison, Wisconsin.

Report for 1896, pp. 205, 206, fig. 1 (E.S.R. Vol. 9, p. 597). "Corn Harvesters, Draft," by F. H. King. "Tests of the draft of the McCormick and Deering self-binding harvesters indicated that 'the team working the Deering corn harvester was doing work equivalent to plowing a 12-inch furrow 4.6 inches deep, and the other team a 12-inch furrow 6.6 inches deep.'"

Arizona Agricultural Experiment Station, Tucson, Arizona.

Bulletin 71, July, 1913, pp. 797-814, pl. 1, figs. 5 (E.S.R. Vol. 31, P. 891).







"Gasoline-engine Troubles," by G. E. P. Smith. "This bulletin is intended primarily for the popular discussion of gasoline-engine troubles, but deals, in addition, with several other important features concerning the care and operation of engines. It deals particularly with 4-cycle engines, which are said to constitute at least 95 per cent of the gasoline engines in use in Arizona. A trouble-hunting chart for gasoline engines is included, which takes up in detail troubles in starting and troubles after starting."

#### U. S. DEPARTMENT OF AGRICULTURE PUBLICATIONS.

- #Office of Experiment Stations Bulletin 191, "Tests of Internal Combustion Engines on Alcohol Fuel," 1907, 89 pages, 13 figs. 20 plates, price 20 cents.
- #Farmers' Bulletin 227, "Use of Alcohol and Gasoline in Farm Engines," 1907, 40 pages, 12 figures, price 5 cents.
- #Department of Agriculture, Bureau of Plant Industry Bulletin 170, "Traction Plowing," 1910, 45 pages, 1 fig.
- #Department of Agriculture Bulletin 174, "Farm Experience with the Tractor," 1915, 44 pages. Part of the data of this bulletin is out of date so that present experience is more favorable than indicated in the bulletin.
- #Farmers' Bulletin 719, "An Economic Study of the Farm Tractor in the Corn Belt," 1916, 24 pages, 1 figure.
- Farmers' Bulletin 963 Tractor Experience in Illinois.
- Farmers' Bulletin 1004 The Gas Tractor in Eastern Farming.
- Farmers' Bulletin 1013 Practical Hints on Running a Gas Engine.
- Farmers' Bulletin 1035 The Farm Tractor in the Dakotas.
- Farmers' Bulletin 1045 Mowing out Fields for Tractor Plowing.

#### MISCELLANEOUS PUBLICATIONS.

- Power and Plow, by L. W. Ellis and E. A. Rumley, Doubleday, Page & Company, New York, N. Y., 1911, 318 pages, 32 chapters.
- The Modern Gas Tractor, - Its Construction, Utility, Operation, and Repair, by Victor W. Page, the Norman W. Henley Publishing Co., New York, 1914, 475 pages, 204 figures.
- Farm Motors, by A. A. Potter, McGraw-Hill Book Co., Inc., New York, 1915, 261 pages, 278 illustrations. (Includes traction engines).
- Traction Engine - Its Use and Abuse, by Jas. H. Maggard, Munn & Co., Inc., New York, 293 pages, 70 illustrations.
- Farm Engines and How to Run Them, by Jas. H. Stephenson, Munn & Co., Inc., New York, 1903, 215 pages, fully illustrated.
- Farm Gas Engines, by C. F. Hirshfeld and T. C. Ulbricht, John Wiley & Sons, New York, 239 pages.
- Gas, Gasoline and Oil Engines, by Gardner D. Hiscox and Victor W. Page, The Norman W. Henley Publishing Co., New York, 1917, 640 pages, 435 illustrations (The tractor is dealt with to some extent).

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#Obtainable only from the Superintendent of Documents, Government Printing Office, Washington, D. C., at price names (stamps not accepted.).



The Gas Line Engine on the Farm - Its Operation, Repair and Use, by  
E. W. Palmer, 1917, 52 pages, 20 engravings. (Contains special  
chapters on the Tractor Engine, What is Best in a Tractor, and  
Operating the Tractor.)  
Standard American Gas & Oil Engine, Automobile, and Farm Engine Guide, by  
Stevenson & Brooks, Chicago, 1923, 719, 232, and 245 pages, 4  
plates, 487 figures. This is an encyclopedia on gas and oil engines,  
including tractor engines, also questions and answers.  
Farm National Farm Tractor Directory - A complete list of farm tractors,  
their manufacturers, horsepower, type, traction and other particulars,  
Compiled by Cass E. Stone, M. E., Georgetown, Pa. The Agricultural  
Digest, July, 1918. The Agricultural Press, Inc., 2 West 45th Street,  
New York.  
Farm Tractors and Farm Motors, L. B. Davidson and L. W. Chase, Chicago  
Road Publishing Co., Chicago, Ill.  
Farm Machine Laboratory Manual, L. W. Wiley, Published by John Wiley and  
Sons, New York.  
Implement Blue Book (Farm Machinery Directory, with specifications for  
tractors, threshers, cutters and spreaders) Midland Publishing Co.,  
St. Louis, Mo.  
Tractor Field Book (Specifications for tractors, threshers, tractor plows,  
cutters, cutters, hay balers, graders, mowers and shellers)  
Farm Implement News, Kansas City, Mo.  
Midland Implement Directory, Kansas City, Mo.  
Implement Trade Journal Co., Kansas City, Mo.  
Mechanics of the Farm, L. B. Davidson, McGraw Hill Co., 1221 West 12th  
Street, New York.  
Agricultural Engineering, L. B. Davidson, Webb Publishing Co., St. Paul,  
Minn.  
Equipment for the Farm and Farmstead, H. C. Ramseyer, Sinn and Co.,  
New York.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF AGRICULTURAL ENGINEERING

Information Series No. 10 (Revised)

January 1932

CLEARING LAND OF SMALL GROWTH

The common methods of clearing land of trees and stumps are discussed in Farmers' Bulletin 1526, "Clearing Land of Brush and Stumps", and the use of explosives in this kind of work is treated in Department Circular 191, "The Use of Explosives in Blasting Stumps". This paper deals with the removal of small growth.

The accompanying sketches illustrate a number of ways of using simple mechanical devices for removing small growth and small stumps.

One of the greatest difficulties encountered in keeping land free from small growth arises in the tendency of stumps and roots to reproduce their kind by putting forth shoots and sprouts. This continues as long as there is life in the roots. It is well to remember, however, that roots cannot continue to live unless they are fed through the leaves put forth above the ground. Therefore, if after once the land is cleared all shoots and sprouts are persistently cut off at the ground or stump surface as fast as they appear, the roots finally will die and no more sprouts will issue.



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### Cutting and burning

A growth of brush may be removed by cutting and burning, by plowing it under, or by pasturing. The cutting and burning method is used when it is desired to put the land immediately into cultivation. The brush should be cut, preferably in the late spring just after the new leaves have attained their full size. The cut brush should be allowed to dry out during the following winter, and then be piled and burned in the spring. The brush may be piled and burned by itself, but wherever there are down-logs, stumps, or other refuse to be burned, the brush should be piled about the larger stuff as it adds very much to the effectiveness of the fire.

### Plowing

Small growth, up to about 3 inches in diameter, can be plowed under by the use of a very heavy plow especially designed for this work. The furrow made by such a plow is from 12 to 18 inches deep and in some soils such deep plowing may be objectionable. The plowing also leaves the ground very rough and uneven. After plowing brush under it is well to go over the land with a disk or spring-tooth harrow. This has a tendency to smooth up the land and to cut and tear the roots which helps to prevent sprouting.

### Pasturing

Where it is not necessary to cultivate the land for two or three years, pasturing is undoubtedly the most economical way of clearing land of brush. Goats are browsers by nature and there is no vegetation they will eat in preference to leaves and twigs of bushes; they







seem to avoid the grasses which other kinds of live stock prefer. Sheep are the next-best browsers, but close pasturing with any kind of live stock is beneficial. The stock should be allowed the run of only so large a tract as they can keep well subdued because the quantity of sprouts and young bushes an animal will nip off depends upon whether or not it has access to other vegetation. It has been reported that 100 Angora goats to each 40 acres of brush land will, in 2 years, make the land as clean and grassy as a lawn. It is desirable to go over the tract in late summer, and with an axe remove the sprouts and bushes which the stock has failed to subdue. Farmers' Bulletin 1203, "The Angora Goat", contains instructions for handling goats.

#### Poisoning

Recently, this Bureau has been investigating the use of poisons in killing brush, but the results to date have not been sufficiently favorable to demonstrate the economy of this method of brush disposal. One of the most effective poisons found is calcium chlorate, which is put in solution in the proportion of one pound of calcium chlorate to one gallon of water. It is applied by spraying the leaves. Certain varieties of small brush or bushes may be killed with one application. Others may require several treatments, and some kinds of brush do not appear to be permanently injured by the treatment. So far, no poison has been found that can be relied on to prevent the sprouting of stumps, nor does the Bureau know of any chemical which will hasten the decay of a stump.







### Special treatments

Several kinds of trees possess peculiar root systems and have an unusual capacity for reproducing themselves. On account of their wide distribution and annoying character, the following comments are given which may be helpful if occasion arises to remove growth of this type.

Sassafras grows very rapidly the first two years, but slowly thereafter. The roots of this tree or bush strike vertically into the ground for approximately 8 to 16 inches, then turn at right angles and pursue a horizontal course for about the same distance when they split into numerous laterals. The usual custom of grubbing sassafras off several inches below the ground serves only as a temporary expedient. The most satisfactory method of dealing with sassafras, if it is large enough, is to pull it out root and branch. Any clamp device, adjusted to a strong handle 5 or 6 feet long, and in such manner as to give a strong leverage, will answer. Sassafras may be exterminated in one grubbing if the root is followed and cut beyond where it makes the turn or angle, but this method is laborious. Repeated and careful plowing, if maintained for several years, will gradually exterminate this bush; but due regard for the condition of the soil will usually not permit such treatment. Sassafras thrives best upon poor lands that are left idle at intervals. The improvement of the soil also tends to subdue it, as rich land is not congenial.

Persimmon and locust are similar to sassafras in underground development and should be treated like sassafras. Locust roots are a little nearer the surface, and are more numerous, attenuated, and tenacious than are the roots of the other two mentioned.







Yellow popular or tulip, cottonwood, soft maple, and sycamore stumps and roots send up numerous and vigorous shoots which if grazed back or repeatedly knocked off will cease to appear after several years because the stumps will rot completely in that time and no life will be left in the roots provided they are kept free of shoots. The sycamore has greater vitality than the other three species and is somewhat more persistent.

The alder is master of the swampy land upon which it thrives, and sends out a profusion of tangled roots. However, if its vulnerable points are understood it may be quickly and easily disposed of. In August, cut the bushes off at or below the crown, leaving them where they fall. The following spring, after the vegetation has started and the ground is sufficiently dry, burn the area over and the alder will never return, provided the work is well done.

#### Use care in burning

Generally speaking, alders grow in a muck or peaty soil and this soil under dry conditions will burn readily. This type of fire is difficult to control as the burning occurs mostly below the surface and will continue even in winter with a foot or more of snow underground. Spring burning with a water table not too low should be reasonably safe provided the fire is watched and the proper protective measures taken.

The necessity of using great care when burning brush of any kind can not be too strongly emphasized. Where the burning is to be done in a timber or cutover area, it is advisable first to see the fire warden and to obtain a burning permit if one is required.







Publications on Land Clearing and Related Subjects

U. S. Department of Agriculture Publications

Farmers' Bulletins:

- 1100, Cooperative Marketing of Woodland Products.
- 1203, The Angora Goat.
- 1210, Measuring and Marketing of Farm Timber.
- 1526, Clearing Land of Brush and Stumps.

Department Bulletins:

- 718, Small Sawmills, Their Equipment, Construction and Operation.
- 741. Effect of Grazing upon Aspen Reproduction.

Department Circular:

- 191, Use of Explosives in Blasting Stumps.

State Publications

(Make request to the State Agricultural College)

Alabama:

- Circular 50, Land Clearing in Alabama Bottom Lands.

Idaho:

- Bulletin 136, Farming Practices for the Cut-over Lands of Northern Idaho.

Minnesota:

- Bulletin 220, Effects of Forest Fires on Land Clearing and Crop Production.
- Bulletin 250, Stoning Farm Lands.
- Circular 16, Minnesota Land Clearing Needs.
- Special Bulletin 97, Land Clearing Practices in Minnesota.

Montana:

- Extension Bulletin 99, Stubble Burning.







Oregon:

Experiment Station bulletin 195, Stump Land Reclamation  
in Oregon.

Washington:

Extension bulletin 62, Destroying Stumps by Charpit Method.  
Extension bulletin 152, Burning Stumps in Western Washington.  
Extension bulletin 163, Forced-draft Stump Burner.  
Bulletin v.8, Concerning Land Clearing.

Wisconsin:

Bulletin 320, Clear More Land.  
Bulletin 332, Farms Follow Stumps.  
Extension circular 148, Keep the Stump Puller Working.  
Extension circular 217, Fire in Land Clearing; Use and Control.

Institute of Makers of Explosives (New York City)

Pamphlet: Explosives in Agriculture.

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Partial List of Manufacturers of Stump Pullers

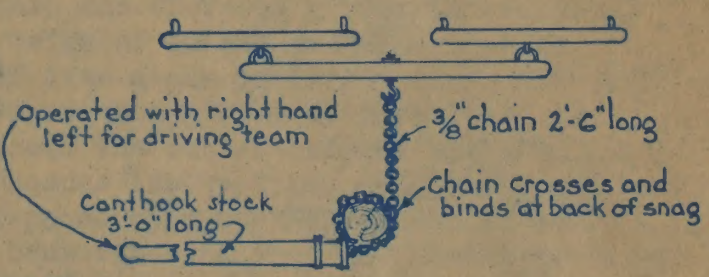
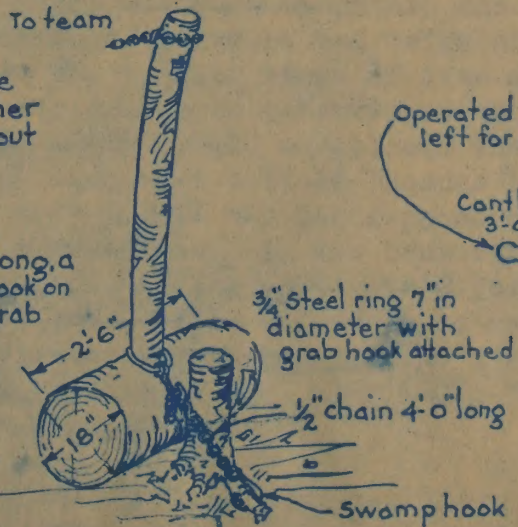
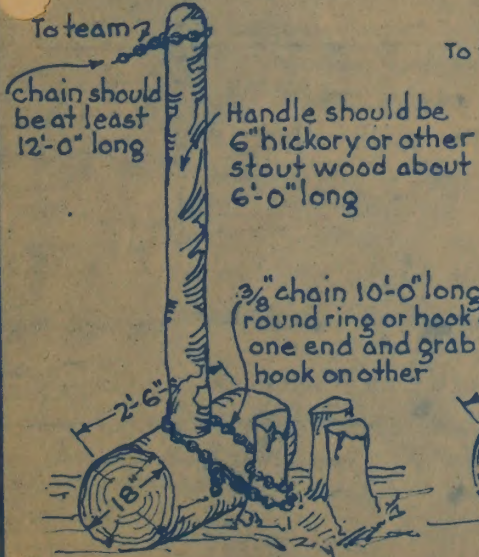
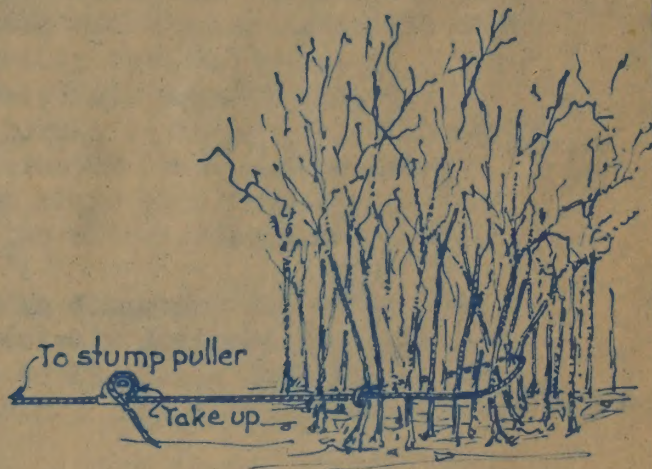
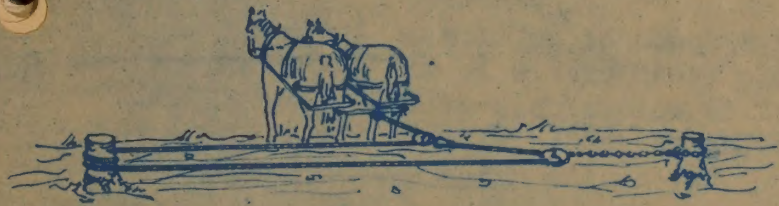
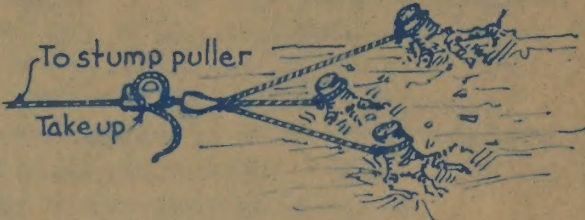
|                       |                     |
|-----------------------|---------------------|
| Bennett Mfg. Co.      | Westerville, Ohio.  |
| Clyde Iron Works,     | Duluth, Minn.       |
| Hercules Mfg. Co.     | Centerville, Iowa.  |
| A. J. Kirstin Co.     | Escanaba, Mich.     |
| W. Smith Grubber Co.  | La Crescent, Minn.  |
| Milne Mfg. Co.        | Monmouth, Ill.      |
| Swenson Grubber Co.   | Cresco, Iowa.       |
| John Waldron Corp.    | New Brunswick, N.J. |
| White and Williamson, | Chattanooga, Tenn.  |

While these firms are believed to be reliable it should not be assumed that their mention implies any particular endorsement by the Department of either the prices or quality of their product.









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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 10 (Revised)

November 1925.

LAND CLEARING.

In adopting a method of clearing agricultural land, one must be governed by the conditions present in each case. Where large areas of land are to be cleared a considerable investment, in equipment and tools, may be justified by a resulting small cost per stump removed. In such cases, the advice of the State Agricultural College, or of other competent authority, should be secured. When the acreage to be cleared is small, or where the stumps to be removed are small in size or in number, it is not necessary nor advisable to buy much equipment. This circular describes some of the simpler methods used under such conditions.

A growth of brush may be removed by cutting and burning, by plowing it under, or by pasturing. The cutting and burning method is used when it is desired to put the land immediately into cultivation. The brush should be cut, preferably, in the early fall when in full leaf, allowed to dry out during the winter and burned in the spring. The brush may be piled and burned by itself, but wherever there are down-logs, stumps or other material to be burned, the brush should be piled about the larger stuff as it adds very much to the effectiveness of the fire.

Small growth, up to about 3 inches in diameter, can be plowed under by the use of a very heavy plow especially designed for this work. The furrow made by such a plow is from 12 to 18 inches deep but in some soils such deep plowing may be objectionable. The plowing also leaves the ground very rough and uneven.

Where it is not necessary to cultivate the land for two or three years, pasturing is undoubtedly the most economical way of clearing land of brush. Goats are browsers by nature and there is no vegetation they will eat in preference to leaves and twigs of bushes and they seem to avoid the grasses which other kinds of live stock prefer. Sheep are the next best browsers, but close pasturing with any kind of live stock is beneficial. The stock should be allowed the run of only so large a tract as they can keep well subdued because the quantity of sprouts and young bushes an animal will nip off depends upon whether or not it has access to other vegetation. It has been reported that 100 Angora goats to each 40 acres of brush land will, in 2 years, make the land as clean and grassy as a lawn. It is desirable to go over the tract in late summer and with an axe remove the sprouts and bushes which the stock has failed to subdue. Farmers' Bulletin 1203, "The Angora Goat", contains instructions for handling goats.

Trees may be removed, where necessary, by grubbing, by blasting or by pulling with some sort of a stump pulling device. It is not generally advisable to cut off a tree with a view of grubbing the stump out later. It is easier to grub the tree than the stump because the trunk and branches act as levers greatly assisting the loosening of the roots.







Trees of considerable size can be removed with little labor by digging a trench immediately around the base of the tree and cutting all the lateral roots, because the tree being thus exposed to the action of wind and water has a greatly reduced resistance. In wet seasons water will collect in the trench softening the soil, and the wind, with its swaying force, will soon blow the tree down.

Trees may be blasted down with explosives in the same way that stumps are blown out. The charges should be but a little heavier than those required for similar green stumps but should be so placed that the roots will be entirely loosened.

Any kind of a pulling device may be used to pull down a tree. The size of the tree, which largely determines the amount of power required, fixes the kind of puller which must be used as the principal difference in pullers is in the amount of power developed. Small trees, 3 or 4 inches in diameter may be pulled by fastening a chain to them high above the ground with a horse hitched to the other end of the chain; while the horse is pulling on the chain a man with an axe will be of material assistance by severing such roots as are loath to give way. Any of the mechanical stump pullers can be used for felling trees in the same manner that they are used on stumps except that the hitch is made around the trunk as far from the ground as is practicable.

Unless there is an immediate or peculiar need for the land, it is less expensive to fell and burn the timber and tops, allowing the stumps to decay for three or four years before removing them, than it is to remove the living trees. Where the trees to be felled are thick, they should be disposed of as fast as they are pulled down or the down trees and tops will greatly interfere with the remainder of the work.

Trees may be poisoned and their decay materially hastened. Caustic soda is largely used for this purpose in certain sections of the country. When used at the proper season, on trees having a circulatory sap system, the claim is made that the poison will permeate the entire tree and its roots, thus accelerating decay and preventing the growth of shoots and sprouts. Information Series #57, "Poisoning Trees" describes the preparation and use of this poison and a copy may be secured from the Division of Agricultural Engineering, Bureau of Public Roads, Washington, D. C.

Stumps may be removed by grubbing, burning, pulling, blasting or allowing time for decay. Grubbing out stumps is probably the oldest method of stump removal but in these days it can only be used economically where labor is both plentiful and cheap.

Under some conditions, it is claimed that it does not pay to remove hardwood stumps but that they should be left in the cultivated fields until the natural processes of decay so weaken them that they can be easily knocked over or pulled out. However, in general, it is doubtful if the saving is not more than counterbalanced by the difficulties of cultivation and area lost to crops during the six or eight years required for the stumps to rot. There are no chemicals which can be placed in a stump to hasten this process of decay. Stumps of certain species, of which the pine is the most common, decay very slowly indeed.







In general, stumps, especially the resinous pines, can be burned with little outlay of money but at the cost of considerable time and labor. The most commonly used method of burning is to dig a hole about 20 inches deep on one side of the stump, clearing the earth away from the tap root. A hole,  $1\frac{1}{2}$  or 2 inches in diameter, beginning on the opposite side of the stump near the surface of the ground, is then bored through the tap root into the bottom of the hole. A fire is then started at the bottom of the hole. The earth must be well banked-up around the stump after the fire is under way, so as to insure the burning of the roots. In the west, where the stumps are large, several types of stump burners have been developed, but their use is not satisfactory on stumps of less than 3 feet in diameter. Hardwood stumps, or those without tap roots, can be burned after blasting a hole under the stump which splits it so that a draft can be obtained. The burning method requires careful and continuous attention to ensure that the roots are destroyed below any possible plow depth. Under favorable conditions, one man can burn about 100 stumps per week.

There are a great variety of methods and machines for pulling stumps ranging from the direct pull by a team to huge machines with immense pulling power. The simplest puller is a chain with a hook on one end and a team with the front wheels of a wagon on the other end. The chain is fastened to one of the main roots of the stump, placed across the top of the stump which acts as fulcrum and thus furnishes a leverage which increases the effectiveness of the power of the team. Tractors are often employed for supplying the power either using a direct pull or by supplementing a block and tackle.

A simple, homemade device, called "Paul Bunyan's Hammer", works efficiently on small or medium sized stumps. This is a large mallet, the head being a log of cedar or other light wood, 18 inches in diameter and 30 inches long, and the handle being of hickory or other tough wood, about 6 inches in diameter and 6 feet long. A pull chain 12 feet long is fastened to the end of the handle. It is operated by placing the head of the mallet as close to the stump as possible with the handle in an upright position against the stump. A heavy chain with a "corner-bind" or "fid hook" attachment is placed around the stump as low as possible and then around the handle where it enters the log; it is essential that this chain be as tight as possible as the greatest leverage is obtained in this way. When the handle is pulled down to a horizontal position by a team, the stump is turned up on the mallet head.

Mechanical stump pullers can be obtained in many sizes, but for small and scattering stumps only the simpler types are necessary. Machines can be purchased for operation either by man or horse power. The one-man puller can be rigged to pull stumps of considerable size, but it is slow in its operation because its speed is sacrificed to secure power. Horse power pullers develop sufficient power but where the stumps are few and scattered the operation requires skillful handling to keep the cost of the work down. Small stump pullers can be obtained at from \$100 to \$500 including the necessary equipment, so that a considerable number of stumps must be pulled to justify an investment of such size.







Blasting may be employed to crack the stump so that it can be easily pulled or burned, or the stump may be blown completely out of the ground.

Dynamites are graded according to the percentage of nitro-glycerin which they contain. This method of grading has very little to do with the strength of the various grades but has a great bearing on the speed of the explosion and the effectiveness of the work. For most conditions of stump blasting, a slow explosive does better work than a fast one, so that ordinarily what is known as a 20 per cent dynamite gives the best results. In very light soils, a 40 per cent may do slightly better work, according to the method used.

Economy in blasting stumps is largely a matter of experience. In general, the charges should be placed well down in the ground and under the center of the stump, or under the points of greatest resistance. The size of charge can only be determined by experiment, under the conditions present in each case. Green stumps require about 50 per cent more charge than similar dry ones. The most economical blasting can be done when the soil is wet or saturated with water. The cost of blasting is variable, but for isolated or widely scattered stumps it is probably the most economical method. All work with explosives should be done carefully and "Safety First" should be the only rule followed. Department Circular 191, "The Use of Explosives in Blasting Stumps" gives detailed instruction as to the use of this method of stump removal.

Recently various surplus war explosives have been re-worked and made available for farmers by the Government. The cost is small and they have been widely used with very satisfactory results. Information as to how to secure them can be obtained from the Division of Agricultural Engineering, Bureau of Public Roads, Washington, D. C.

There are several varieties of trees possessing a peculiar root system and having a wonderful capacity for reproducing themselves. On account of their wide distribution and annoying character the following comments are given which may be helpful if occasion arises to remove species of this kind.

Sassafras grows very fast the first two years but slowly afterwards. The roots of this tree or bush strike perpendicularly into the ground for approximately 8 to 16 inches, then turn at right angles, rarely both ways, and pursue a horizontal course for about the same distance when they split into numerous laterals. The usual custom of grubbing sassafras off several inches below the ground serves only as a temporary expedient. The most satisfactory method of dealing with sassafras, if it is large enough, is to pull it out root and branch. Any clamp device, adjusted to a strong handle 5 or 6 feet long, and in such manner as to give a strong leverage, will answer. The sassafras may be exterminated in one grubbing if the root is followed and cut beyond where it makes the turn or angle, but this method is laborious. Constant and careful plowing, if maintained for several years, will gradually exterminate this bush; but due regard for the condition of the soil will usually not permit such treatment. Sassafras thrives best upon poor lands that are left idle







at intervals. The improvement of the soil also tends to subdue it, as rich land is not congenial. Persimmon and locust are very similar to sassafras and should be treated in like manner. The locust roots are a little nearer the surface, more numerous, attenuated and tenacious than the other two mentioned.

The yellow popular or tulip, cottonwood, soft maple and sycamore send up numerous and vigorous shoots which if grazed back or knocked off will cease to appear in several years because the stumps will rot completely in this time and no life will be left in the roots provided they are robbed of shoots. The sycamore has greater vitality than the other three species and is somewhat more persistent.

The alder is master of the swampy land upon which it thrives, sending out a profusion of tangled roots. However, if its vulnerable points are understood it may be quickly and easily disposed of. In August cut the bushes off at or below the crown, leaving them where they fall. The following spring, after the vegetation has started and the ground is very dry, burn the area over and the alder will never return, provided the work is well done.

#### Bulletins Published on Land Clearing.

Very few of these publications are at present available except for consultation at Libraries.

#### Government Publications.

Bureau of Plant Industry Bulletin 239 (1912), "Cost and Methods of Clearing Land in Western Washington."

Bureau of Chemistry Circular 25, "The Cost of Clearing Logged-off Land for Farming in the Pacific Northwest."

Farmers' Bulletins: (U. S. Department of Agriculture)

- # 150, "Clearing New Land." (1902)
- # 463, "The Utilization of Logged-off Land for Pasture in Western Oregon and Western Washington."
- # 600, "An Outfit for Boring Taprooted Stumps for Blasting."
- # 974, "Clearing Land."
- #1023, "Machinery for Cutting Fire Wood."
- #1100, "Cooperative Marketing Woodland Products."
- #1203, "The Angora Goat."
- #1210, "Measuring and Marketing of Farm Timber."

Department Bulletins: (U. S. Department of Agriculture)

- # 91, "Costs and Methods of Clearing Land in the Lake States."
- # 711, "Logging in the Douglas Fur Region."
- # 718, "Small Sawmills, Their Equipment, Construction & Operation."
- # 738, "Effect of Grazing upon Western Yellow Pine Reproduction in Central Idaho."
- # 741, "Effect of Grazing upon Aspen Reproduction."



SECRET

*[Faint handwritten notes at the bottom of the page]*



Department Bulletins (Cont'd): (U. S. Department of Agriculture)

- #1140, "Deterioration of Felled Western Yellow Pine on Insect Control Projects."
- #1176, "Some Results of Cutting in the Seirra Forests of California."
- #1200, "The Natural Regeneration of Douglas Fir in the Pacific N.W."
- #1236, "Farming the Logged-off Upland in Western Washington."

Department Circulars: (U. S. Department of Agriculture)

- # 94, "T.N.T. as a Blasting Explosive."
- #191, "Use of Explosives in Blasting Stumps."

- Bureau of Mines - Bulletin # 10, "The Use of Permissible Explosives."  
" " " " # 15, "Investigations of Explosives Used in Coal Mines."  
" " " - Technical Paper 6, "The Rate of Burning of Fuse as Influenced by Temperature and Pressure."  
" " " - Technical Paper 17, "The Effect of Steaming on the Efficiency of Explosives."  
" " " - Technical Paper 18, "Magazines and Storehouses for Explosives."

Experiment Station Publications.

- Idaho Bulletin 91, "Methods of Clearing Logged-off Land."  
Kentucky Bulletin 154, "Blowing Stumps with Dynamite."

Minnesota Bulletins:

- # 81, Contains notes on the methods employed and cost in clearing lands at the Northeast Experiment Farm.
- #116, "Clearing Lands."
- #134, "Land Clearing."
- #163, "Investigations in Cost and Methods of Clearing Land."
- #189, "Forced Vs. Delayed Systems of Clearing Stump Land."
- #208, "Investigations in Stumps and Stone Removal."
- Special Bulletin 60, "Simple Steps in Land Clearing."

Mississippi Bulletins:

- # 79, "Clearing Pine Land."
- #118, " " " "
- #159, " " " "

Montana Special Bulletins:

- # 60, "Simple Steps in Land Clearing."
- # 65, "Making a Living on a Timber Farm."



Department of Agriculture  
Bureau of Plant Industry  
Washington, D. C.

Mr. J. B. ...  
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Very respectfully,  
J. B. ...

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Washington Bulletins:

# 1, Special Series, "Clearing Land."  
 # 7, " " " "  
 # 8, " " " "  
 # 28, "Clearing Land."  
 # 93, " "  
 #101, " "  
 Popular Bulletin 40, "Charpit Method of Destroying Stumps."  
 Extension Bulletin 62, "Destroying Stumps by Charpit Method."

Wisconsin Bulletins:

#216, "Clearing Land."  
 #295, "Getting Rid of the Stumps."

Partial List of Makers of Explosives:

|                                 |                       |
|---------------------------------|-----------------------|
| Aetna Explosives Co. Inc.,      | New York, N. Y.       |
| Atlas Powder Company,           | Wilmington, Del.      |
| Austin Powder Co.,              | Cleveland, Ohio.      |
| E. I. Du Pont de Nemours & Co., | Wilmington, Del.      |
| Egyptian Powder Company,        | East Altoona, Ill.    |
| Equitable Powder Mfg. Co.,      | " " "                 |
| Elcelsior Powder Mfg. Co.,      | Kansas City, Mo.      |
| The Giant Powder Co.,           | San Francisco, Calif. |
| The Grasselli Powder Co.,       | Cleveland, Ohio.      |
| Hercules Powder Co.,            | Wilmington, Del.      |
| Illinois Powder Mfg. Co.,       | St. Louis, Mo.        |
| King Powder Co.,                | Cincinnati, Ohio.     |
| Monongahela Powder Co.,         | Fairmont, West Va.    |
| Senior Powder Co.,              | Cincinnati, Ohio.     |
| Standard Powder Co.,            | Philadelphia, Pa.     |
| U. S. Powder Co.,               | Terre Haute, Ind.     |

Partial List of Manufacturers of Stump Pullers:

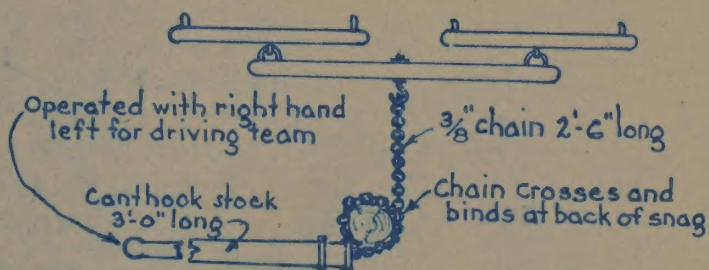
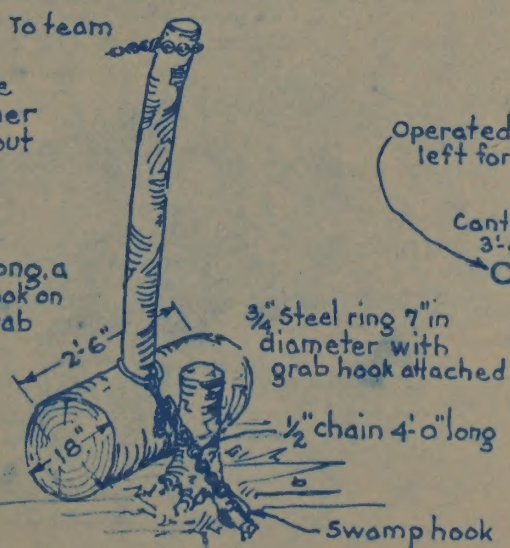
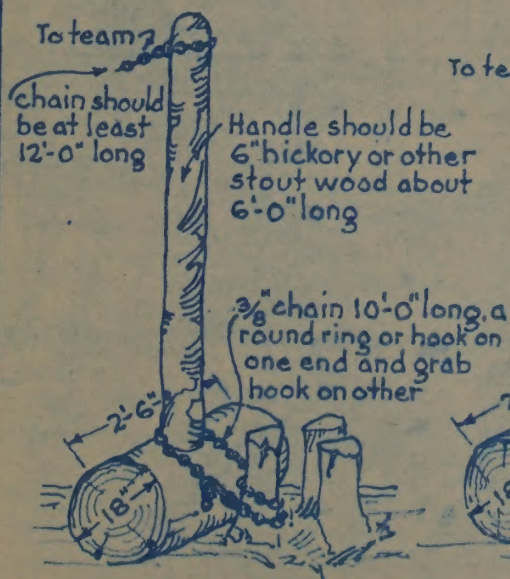
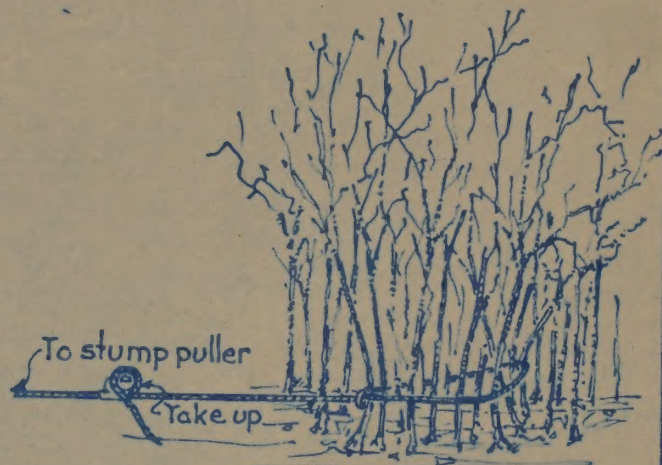
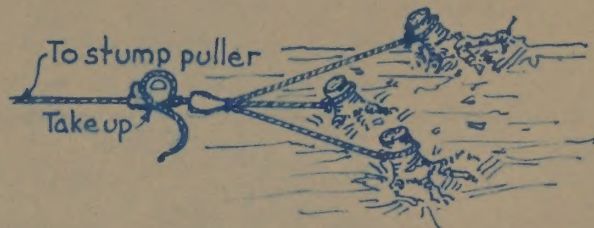
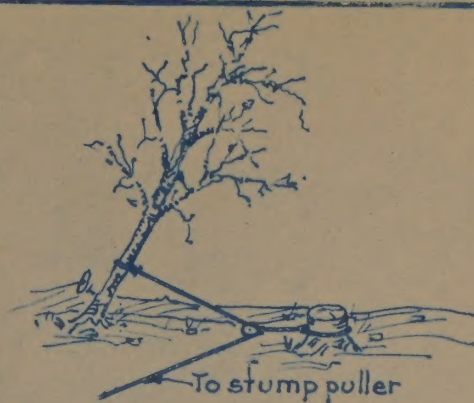
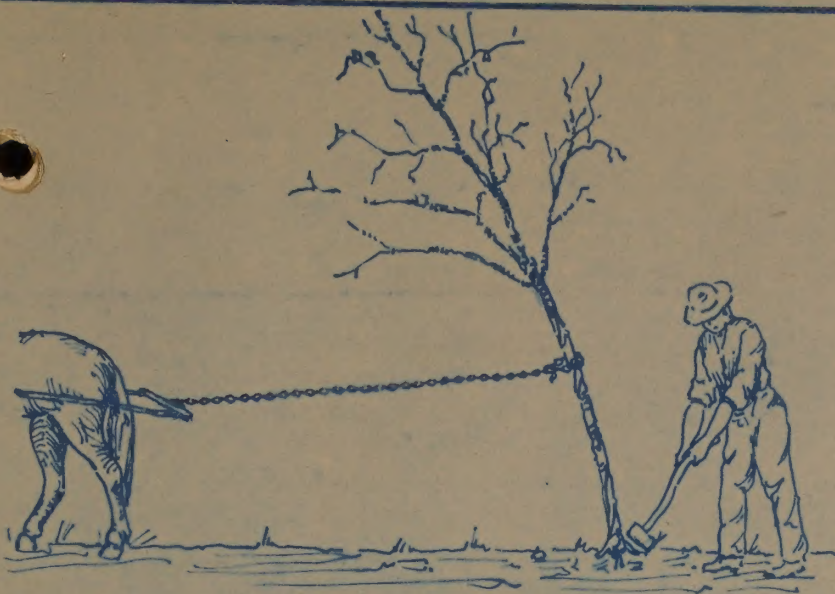
|                             |                    |
|-----------------------------|--------------------|
| Milne Mfg. Co.,             | Monmouth, Ill.     |
| H. L. Bennett & Co.,        | Westerville, Ohio. |
| C. D. Edwards,              | Albert Lea, Minn.  |
| Faultless Stump Puller Co., | Cresco, Iowa.      |
| Hercules Mfg. Co.,          | Centerville, Iowa. |
| A. J. Kirstin Co.,          | Escanaba, Mich.    |
| Kansas City Hay Press Co.,  | Kansas City, Mo.   |
| Monarch Tractor Co.,        | Watertown, Wis.    |
| W. Smith Grubber Co.,       | La Crescent, Minn. |
| Swenson Grubber Co.,        | Cresco, Iowa.      |

While these firms are believed to be reliable it should not be assumed that their mention implies any particular endorsement by the Department or either the prices or quality of their products.









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| U.S. DEPARTMENT OF AGRICULTURE       |                |                     |
| BUREAU OF PUBLIC ROADS               |                |                     |
| DIVISION OF AGRICULTURAL ENGINEERING |                |                     |
| LAND CLEARING                        |                |                     |
| Scale                                | CHECKED        | SHEET ① OF ① SHEETS |
| Drawn by                             | Traced by N.B. |                     |
| APPROVED                             | 2152           |                     |

To accompany Information Series #10







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

Information Series - No. 11

February, 1916.

BALL BEARINGS, ROLLER BEARINGS, ETC.

(a) Coefficients of Friction of Roller Bearings. C. H. Benjamin (Machinery, Oct., 1905).--Comparative tests of plain babbitted, McKeel plain roller, and Hyatt roller bearings gave the following values of the coefficient of friction at a speed of 560 r.p.m.:

| Diameter<br>of<br>Journal | Hyatt Bearing |      |      | McKeel Bearing |      |      | Babbitt Bearing |      |      |
|---------------------------|---------------|------|------|----------------|------|------|-----------------|------|------|
|                           | Max.          | Min. | Ave. | Max.           | Min. | Ave. | Max.            | Min. | Ave. |
| 1-15/16                   | .032          | .012 | .018 | .033           | .017 | .022 | .074            | .029 | .043 |
| 2-5/16                    | .019          | .011 | .014 | ....           | .... | .... | .088            | .078 | .082 |
| 2-7/16                    | .042          | .025 | .032 | .028           | .015 | .021 | .114            | .083 | .096 |
| 2-15/16                   | .029          | .022 | .025 | .039           | .019 | .027 | .125            | .089 | .107 |

The friction of the roller-bearing is from one-fifth to one-third that of a plain bearing at moderate loads and speeds. It is noticeable that as the load on a roller-bearing increases the coefficient of friction decreases.

A slight change in the pressure due to the adjusting nuts was sufficient to increase the friction considerably. In the McKeel bearing the rolls bore on a cast-iron sleeve and in the Hyatt on a soft-steel one. If roller bearing are properly adjusted and not over loaded a saving of from 2-3 to 3-4 of the friction may be reasonably expected.

McKeel bearings contained rolls turned from solid steel and guided by spherical ends fitting recesses in cage rings at each end. The cage rings were joined to each other by steel rods parallel to the rolls.

(a) Saving of power by Use Ball-Bearings.-- Henry Hess (Trans. A. S. M. E., 1909) describes a series of tests made by Dodge and Day on a 2-15/16 in. line shaft 72 ft. long, alternately equipped with plain ring-oiling babbitted boxes and with Hess-Bright ball-bearings. Eight countershafts were driven from pulleys on the line shaft. The countershaft pulleys had plain bearings. The conclusions from the tests made under normal belt conditions of 44 and 57 lbs. per inch width of angle of single belt are as follows:

a. Savings due to the substitution of ball-bearings for plain bearings on line shafts may be safely calculated by using 0.0015 as the coefficient of ball-bearing friction, 0.03 as the coefficient of line shaft friction, and 0.08 as the coefficient of countershaft friction.

b. When the belts from line shaft to countershaft pull all in one direction and nearly horizontally the saving due to the substitution of ball-bearings for plain bearings on the line shaft may be safely taken as 35% of the bearing friction.

(a) taken from Kent's Mechanical Engineers' Pocket Book, 9th Edition, 1916.







c. When ball-bearings are used also on the countershafts the savings will be correspondingly greater and may amount to 70% or more of the bearing friction.

d. These percentages of savings are percentages of the friction work lost in the plain bearings; they are not percentages of the total power transmitted. The latter will depend upon the ratio of the total power transmitted to that absorbed in the line and countershafts.

e. The power consumed in the plain line and countershafts varies, as is well known, from 10 to 60% in different industries and shops. The substitution of ball-bearings for plain bearings on the line shaft only, under conditions of paragraph "a", will thus result in saving of total power of  $35 \times 0.10 = 3.5\%$  to  $35 \times 0.60 = 21\%$ . By using ball-bearings on the countershafts also, the saving of total power will be from  $70 \times 0.10 = 7\%$  to  $70 \times 0.60 = 42\%$ .

(a) Horse-power Required to Drive Shafting.---Samuel Webber in his "Manual of Power" gives, among numerous tables of power required to drive textile machinery, a table of results of tests of shafting. A line of 2-1/8 in. shafting, 342 ft. long, weighing 4098 lb., with pulleys weighing 5331 lb., or a total of 9429 lb., supported on 47 bearings, 216 revolutions per minute, required 1.858 H. P. to drive it. This gives a coefficient of friction of 5.52%. In seventeen tests the coefficient ranged from 3.34% to 11.4%, averaging 5.73%. J. T. Henthorn states (Trans. A.S.M.E., vi, 462) that in print-mills which he examined the friction of the shafting and engine was in " cases below 20% and 30%, in 11 cases from 30% to 35% and in 2 cases above 35%, the average being 25.9%. Mr. Barrus in eight cotton-mills found the range to be between 15% and 25.7%, the average being 22%. Mr. Flather (Dynamometers) believes that for shops using heavy machinery the percentage of power required to drive the shafting will average from 40% to 50% of the total power expended. Under the head of shafting are included elevators, fans and blowers.

Comparative Tests of Three Types of Bearings.---By Carl C. Thomas, E. R. Mauer, and L. E. A. Kelso. (Proceedings A.S.M.E., March, 1914). These were experiments at the University of Wisconsin, made in cooperation with the manufacturers, to determine the absolute and relative amounts of power required to drive a series of uniformly loaded and flexibly connected shafts using babbitt bearings, roller bearings, and ball bearings. The following table shows the relative amounts of power consumed in friction by the three kinds of bearings at the speeds and temperatures indicated. The relative numbers are based on the average power for three loads, 710, 1210, and 1710 lbs., for balls; 740, 1240, and 1740 lbs. for rollers; and 730, 1230, and 1730 for babbitt.

| Bearings     | 100 ft. per min. |          | 300 ft. per min. |          |
|--------------|------------------|----------|------------------|----------|
|              | 77 deg.          | 100 deg. | 77 deg.          | 100 deg. |
| Ball.....    | 1                | 1        | 1                | 1        |
| Roller.....  | 2.2              | 2.5      | 2.7              | 3        |
| Babbitt..... | 3                | 3.6      | 4.5              | 4        |







The Friction Load of Shaft Bearings (Power represented by friction of different bearings and motor drive arrangements), "Electrical World," Oct. 9, 1915, p. 809.

Lubrication of Ball Bearings, "Machinery," July, 1915.

Partial list of ball and roller bearing manufacturers:

- Auburn Ball-Bearing Co., 33 Elizabeth St., Rochester, New York.
- Garney Ball-Bearing Co., Jamestown, New York.
- Hess-Bright Mfg. Co., Philadelphia, Pennsylvania.
- Hoover Steel Ball Co., Ann Arbor, Michigan.
- Hyatt Roller Bearing Co., Newark, New Jersey, or Detroit, Michigan.
- New Departure Ball-Bearing Co., Bristol, Connecticut.
- Rogersford Foundry & Machine Co., Philadelphia, Pennsylvania.
- S. K. F. Ball-Bearing Co., 50 Church St., New York.
- The Ball and Roller Bearing Co., Danbury, Connecticut.
- The Bantam Anti-Friction Co., Bantam, Connecticut.
- The Fafnir Bearing Co., New Britain, Connecticut (Ball and roller)
- The Norm Co. of America, 1790 Broadway, New York.
- U. S. Ball Bearing Co., Oak Park, Illinois.







U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

Information Series - No. 12. (revised)

Void  
Superseded  
by 7. B 1227  
December, 1917.

SEWAGE DISPOSAL AND SANITATION

U. S. DEPARTMENT OF AGRICULTURE PUBLICATIONS.

- \*Farmers' Bulletin 270, Modern Conveniences for the Farm Home, 1906, 48 pages, 26 figs.
- Farmers' Bulletin 345, Some Common Disinfectants, 1908, 12 pages, no figs.
- \*Farmers' Bulletin 463, The Sanitary Privy, 1911, 32 pages, 9 figs.
- Farmers' Bulletin 480, Practical Methods of Disinfecting Stables, 1912, 16 pages, 8 figs.
- \*Farmers' Bulletin 527, contains article on "Sewage Disposal for Rural Homes", 1913, 24 pages, 7 figs., 5 cents.
- \*Bureau of Plant Industry Bulletin 115, The Disinfection of Sewage Effluents for the Protection of Public Water Supplies, 1907, 47 pages, 10 cents.
- \*Department Bulletin 57, Water Supply, Plumbing and Sewage Disposal for Country Homes, 1914, 46 pages, 38 figs., 10 cents.
- \*Year Book Separate 712, Sewage Disposal on the Farm.

OTHER GOVERNMENT PUBLICATIONS.

- Price List 51, "Government Publications Relating to Health, Disease and Sanitation, for sale by the Superintendent of Documents, Washington, D. C." This is furnished free upon request.
- Bureau of the Census, Washington, D. C., Special Report; General Statistics of Cities; 1909, Including statistics of sewers and sewage disposal, refuse collection, and disposal, street cleaning, dust prevention, highways, and the general highway service of cities having a population of over 30,000 1913. 197 pages, 33 tables, 12" x 9-1/2".
- Geological Survey, Washington, D. C., Water Supply Paper No. 229, The Disinfection of Sewage and Sewage Filter Effluents, by E. B. Phelps, 1909, 91 pages, 1 plate.
- \*"Sanitation on Farms", in Smithsonian Report, 1910. pages 651-657. Price of whole report, cloth, \$1.10.
- Public Health Service, Washington, D. C.:
  - Bulletin 37, Sanitary Privy, Its Purpose and Construction, 1910, 24 pages, illustrated.
  - Bulletin 42, Disinfectants, Their Use and Application in Prevention of Communicable Diseases.
  - \*Bulletin 68, Safe Disposal of Human Excreta at Unsewered Houses, 5 cents.
  - \*Reprint No. 54, No. 11, 1910, Preliminary Note on a Simple and Inexpensive Apparatus for Use in Safe Disposal of Night Soil. 5 cents.
  - Reprint No. 70, Mar. 24, 1911 to Jan. 19, 1912, inc., Municipal Ordinances, Rules and Regulations Pertaining to Public Hygiene, Adopted from Jan. 1, 1910 to June 30, 1911, by Cities of the U. S. having a population of over 25,000 in 1910, 224 pages.







- Reprint No. 77, Apr. 26, 1912, Sewage-Polluted Water Supplies in Relation to Infant Mortality.
- Reprint No. 81, 1912, Sanitary Advice for Summer Tourists and Sanitary Advice for Keepers of Summer Resorts, 7 pages.
- Reprint No. 116, Feb. 7, 1913, Country Schools and Rural Sanitation--Six Sample Schools in One County--Does this County Need Medical Inspection in its Schools--The Country School Teacher, 5 pages.
- Reprint No. 138, New Design for Sanitary Pail.
- Reprint No. 177, Feb. 6, 1914, Rural Schools,-- Sanitary Survey of Schools in Bartholomew County, Indiana, 16 pages.
- Reprint No. 185, Report of Sanitary Survey, St. Joseph, Mo.
- \*Reprint No. 247, Jan. 1915, Sewage Disinfection for Vessels and Railway Coaches, 7 pages, 1 fig., 5 cents.
- Supplement No. 2 to the Public Health Reports, Jan. 31, 1913, Indoor Tropics--The Injurious Effect of Overheated Dwellings, Schools, Etc., 8 pages.
- From Public Health Reports, Vol. 27, Nos. 4-40. Municipal Ordinances, Rules, and Regulations Pertaining to Public Health, Adopted July 1, to Dec. 31, 1911, by Cities of the U. S. Having a Population of over 10,000 in 1910.

#### PARTIAL LIST OF COLLEGE PUBLICATIONS ON SEWAGE DISPOSAL.

- South Carolina (Clemson College, S. C.) Bulletin 89, May 1904, "Rural Sanitation" 31 pages, 9 figs.--Topics discussed are the dangers of dust, school-room sanitation, sewage disposal, disinfection, water supply, milk, food, and the dangers from insects.
- Kansas State Agricultural College (Manhattan, Kansas) Bulletin 143, Feb. 1907, "Sewage Disposal", pages 125-139, 8 figs. Several plans presented for septic tanks, suitable for farms; Cost of construction; Information on choosing location for and construction of wells.
- New Jersey, Rutgers College Agricultural Experiment Station (New Brunswick, N.J.) Bulletin 166, June 1903, "Sewage Disposal; Decomposition of Sewage; Disease germs; Proper Construction of an earth closet.
- Cornell University (Ithaca, N.Y.). "The Cornell Reading Courses, Vol. III, No. 59,-- Sanitation Series, No. 4, - Sewage Disposal for Country Homes, by Howard W. Riley", pages 149-187, 95 figs.
- University of Wisconsin (Madison, Wis.) Bulletin 245, Feb. 1915, The Disposal of Creamery Waste, 20 pages, 8 figs.
- Kansas State Agricultural College (Manhattan, Kansas) has a Home Study Correspondence Course in Sanitation.
- Iowa State College (Ames, Ia.) Engineering Experiment Station Bulletins: Vol. IV, No. 6, Sewage Disposal Plant for Private Houses. No. 26, The Production of Excessive Hydrogen Sulfid in Sewage Disposal Plants and Consequent Disintegration of the Concrete.

#### PARTIAL LIST OF STATE BOARDS OF HEALTH PUBLICATIONS.

##### Vermont (Rutland, Vt.) Bulletins:

- Vol. XV, No. 3, March 1, 1915, Sewage Disposal Number, 64 pages, illustrated by plans, 16 figs.
- Vol. XV, No. 2, Dec. 1, 1914, contains four articles on rural sanitation, farm hygiene, sewage disposal in the country, and the problem of water and ice supply, etc., 16 pages altogether.







North Carolina (Raleigh, N. C.) Bulletins:

No. 12, July, 1912, Residential Sewage Disposal Plants, 13 pages, 7 figs.

No. 43, Practical Privies.

No. 47, Privy Leaflet.

No. 51, Rules and Regulations of County Boards of Health.

Virginia (Richmond, Va.) Monthly Health Bulletins:

Vol. IV, May 25, 1912, Extra No. 1, The Fundamentals of Farm Sanitation, pages 75-88, 4 figs.

Vol. V, reprinted Apr. 30, 1913, Extra No. 3, The Sanitary Privy, 4 pages, 3 figs.

Vol. V, June, 1913, No. 6, Good Health in Summer--What it Costs and How to Get it, pages 86-100, 5 figs.

Vol. VII, June, 1915, No. 6, The Danger Zone on the Farm--Sewage Disposal, pages 248-262, 8 figs.

Ohio (Columbus, O.) Annual Reports, etc.

Minnesota (St. Paul, Minn.), Sewage Disposal in Unsewered Districts, 1915 (?), 15 pages, 8 figs.

Michigan (Lansing, Mich.) Monthly Bulletins.

Massachusetts (Boston, Mass.) Annual Reports, etc.

Maine (Augusta, Me.) Circular No. 100, Hygiene of Rural, Suburban and Summer Homes, 1915 (?) 44 pages, 23 figs.

Kentucky (Lexington, Ky.) Bulletin, July, 1914, Vol. III, The Kentucky Sanitary Privy, pages 5-13, 10 figs.

Indiana (Indianapolis, Ind.) Health Circular 1913, Typhoid Fever--Its Cause and Prevention, Methods by which Sewage May be Disposed of so as not to Cause Typhoid Fever, pages 8-13, 6 figs.

California (Sacramento, Cal.) Monthly Bulletin, Vol. 8, No. 12, June, 1913, A Review of Some Available Methods of Sewage Treatment for California, by Chas. G. Hyde, Consult. Eng. Cal. State Board of Health, Reprinted from the Nov. 1911, Bulletin, pages 263-284. Contains also data on 15 septic tanks plants for populations of 1,000 to 25,000. This is also printed as Bulletin Separate No. 6.

PARTIAL LIST OF BOOKS AND PAMPHLETS ON SEWAGE AND SEWAGE DISPOSAL.

American Sewage Practice. Vol. III, Disposal of Sewage, By Leonard Metcalf and Harrison P. Eddy, 1915, McGraw-Hill Book Co., Inc., New York. 851 pages, illustrated.

Elements of Sanitary Engineering, by Mansfield Merriman, 1906. John Wiley & Sons, New York, 250 pages, illustrated.

The Sanitation, Water Supply, and Sewage Disposal of Country Homes, by Wm. Paul Gerhard, 1915. D. Van Nostrand Co., 23 Murray St., New York.

Modern Methods for Sewage Disposal for Towns, Public Institutions and Isolated Houses, by Geo. E. Waring, 1903. D. Van Nostrand Co., 23 Murray St., New York.

Hygiene and Sanitation, by Senaca Egbert. Lea Bros. & Co., New York.

Sewage Disposal, by Geo. W. Fuller, 1912, McGraw-Hill Book Co., New York.

Sewers and Drains, by Anson Marston, 1909. Published by American School of Correspondence, Chicago. 156 pages. 50 figs. A practical treatise on the selection, design, and construction of sewage and drainage systems, and on sewage disposal plants.







- Sewage, by Folwell. Publishers, John Wiley and Sons, New York.  
Sewage Treatment, by Venable; and Sewage, by Rideal. John Wiley & Sons, N.Y.  
Sewage Disposal in America, Trans. American Soc. of Civil Engineers, Vol. 54, pages 147-182.  
The Practical Operation of Sewage Purification Plants, by John W. Alvord.  
Sewage Disposal, by Kinnicutt, Winslow, and Pratt. New York, 1910.  
Universal Portland Cement Co., Chicago, Ill., "The Farm Cement News", Vol. 1, No. 6, illustrated. Instructions for making concrete septic tanks, pages 40-45.

#### ARTICLES ON ACTIVATED SLUDGE METHOD OF SEWAGE DISPOSAL.

- "The Aeration or Activation of Sewage - New Method of Sewage Treatment Sufficiently Developed for Adoption in Full-Sized Plants. Experimental Work at Brooklyn, N. Y. Increases Confidence in this System. The Contract Record, Toronto, Feb. 2, 1916. 3-1/2 pages. G. T. Hammond.  
"Activated Sludge in America", Engineering News, July 22, 1915.  
An editorial survey by M. N. Baker, reviewing all the experiments and installations of this character installed to date of issue.  
"Brooklyn Sewage Aeration and Activated Sludge Experiments", E. J. Fort. Engineering News, July 29, 1915. 2400 words, illustrated. Results of experiments with and without activated sludge.  
"The World's First Full-Scale Plant for the Treatment of Sewage by the Activated Sludge Process". Engineering and Contracting, Oct. 27, 1915, 5,000 words, illustrated.  
Design and Cost in Milwaukee Plant.  
"Milwaukee's Activated Sludge Plant, The Pioneer Large-Scale Installation", T. Chalkley Hutton. Engineering Record, Oct. 16, 1915. 3500 words, illustrated. Design and probable operating costs.  
"Brief Notes of Experiments in Sewage Purification by Forced Aeration", J. P. Wakeford, Survey, July 30, 1915. 7,000 words.  
"Activated Sludge Experiments at Milwaukee, Wis.", Part I, by T. Chalkley Hutton. Engineering News, Feb. 10, 1916, pages 262-3 2300 words. Results of the most expensive experiments on the subject.

#### SOME COMMON DISINFECTANTS AND DEODORANTS.

##### Disinfectants.

Carbolic Acid  
Chloride of Lime  
Cresol  
Sodium Hypochlorite  
Iron Sulphate

Liquid Chloride  
Liquid Formaldehyde  
Carbolic and sulphuric acids - equal parts. Use 2 or 3% solution. This will corrode metals if kept long in contact.

##### Deodorants.

Calcium Hydrate (1 lb. of lime to 4 lbs. of water)  
Sulphate of Iron (4 lbs. to the cubic yard of mass)  
Zinc chloride  
Earth, Charcoal, Ashes, and similar substances.







PARTIAL LIST OF MANUFACTURERS OF SEWAGE SIPHONS, EJECTORS, CHEMICAL CLOSET SYSTEMS, ETC.

Pacific Flush Tank Co., 4241 E. Ravenswood Ave., Chicago, (The Miller Siphon)  
The Modern Iron Works, Quincy, Ill. (Rhodes-Williams Siphon)  
Merritt Hydraulic Co., 112 N. Broad St., Philadelphia, Pa. (Flush tanks, sprinkler nozzles, siphons, Priestman Systems, ejectors)  
F. Story & Sons, Cedar Rapids, Iowa. (Siphons)  
Sanitary Mechanical Specialty Co., 157 E. 72nd St., New York. (McClintock S.M.S. Sewage Ejector)  
Yeomans Bros., 231 Institute Place, Chicago, Ill. (Yeomans Duplex Electric Ejectors)  
Chicago Pump Co., 918 W. Lake St., Chicago, Ill. (Duplex Electric Ejectors, etc)  
Kewanee Water Supply Co., Kewanee, Ill. (Sewage disposal plants, etc.)  
The Blaisdell Mach. Co., Bradford, Pa. (Blaisdell automatic sewage ejectors)  
I. X. L. Pump and Mfg. Co., 959-61 W. 9th St., Phila., Pa. (I.X.L. ejectors)  
Penberthy Injector Co., Detroit, Mich. (Penberthy SL-96 ejectors)  
The John Wieben Co., Inc. 2428 Second Ave., New York. (Ejectors)  
The Waterman-Waterbury Co., Minneapolis, Minn. (Pail chemical closets)  
West Disinfecting Co., 2 E. 42nd St., New York. (Pail chemical closets and cottage systems)  
National Manufacturing Co., Ogdenburg, N. Y. (Chemical pail closets)  
Sanitary Chemical Closet Co., Inc., Bradford, Pa. (Hawkeye direct closet and chemical tank system)  
Sears, Roebuck & Co., Chicago, Ill. (Hawkeye direct closet and chemical tank system.)  
Kanstine Co., Inc., 1072 Ellicott Sq., Buffalo, N. Y. (Chemical closet systems)  
The Rowe Sanitary Mfg. Co., 209 D. 6th St., Detroit, Mich. (Chemical closet systems).

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U. S. DEPARTMENT OF AGRICULTURE  
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING  
DIVISION OF RURAL ENGINEERING

Information Series No. 13. (revised)

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add  
not up to date*  
April, 1917.

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LIME - ITS MANUFACTURE, USES, ETC.  
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U. S. DEPARTMENT OF AGRICULTURE.

- \*Farmers' Bulletin 77, (Revised - Reprint 1909). "The Liming of Soils". 5 cents.
- \*Bureau of Plant Industry Bulletin 1, "Relation of Lime and Magnesia to Plant Growth; Liming of Soils from Physiological Standpoint". 1901, 53 pages, illustrated. 10 cents.
- Bureau of Soils Bulletin 48, "Fertility of Soils as Affected by Manures".
- \*Bureau of Plant Industry Circular 130, "Simple and Economical Method of Burning Lime". 1913. Pages 19 to 23, illustrated. 5 cents.

U. S. GEOLOGICAL SURVEY, (WASHINGTON, D.C.) PUBLICATIONS.

- Separate "h" of Part II of "Mineral Resources of the United States, 1910", "Technologic Investigations of Lime", cited by E. F. Burchard. Published in 1911.
- In 17th Annual Report, Part 3, pages 795-811, "The Limestone Quarries of Eastern New York, Western Vermont, Massachusetts, and Connecticut".
- Part II of Mineral Resources of the U. S. calendar year 1913, pp. V, and 1509-1593, pls. 2, figs. 4. The Source, Manufacture, and Use of Lime. It contains a short section on agricultural lime.

BUREAU OF STANDARDS (WASHINGTON, D.C.) PUBLICATIONS.

- Circular 30, "Lime: Its Properties and Uses". 1911, 22 pages. No longer available from Bureau of Standards or Supt. of Documents, but may be consulted in principal libraries.
- Technologic Paper 16, "Manufacture of Lime". 1913. 130 pages, 30 figs. Process of Manufacture of Quicklime; Heat Mitigation and Efficiency; Manufacture of Hydrated Lime. Full explanation of subject and in appendix the plants of 20 companies are described. Many references given.

STATE EXPERIMENT STATION PUBLICATIONS.

- Note: It is probable that at least some of the following State Experiment Station bulletins are not available, therefore brief abstracts (from the Experiment Station Record) are here given:
- Delaware Agricultural Experiment Station, Newark, Delaware.
  - Bulletin 104. (1914) pp. 20, figs. 1 (E.S.R. Vol. 32). The various lime compounds available for agricultural purposes are described and their use for fertilizing is explained.
- Illinois Agricultural Experiment Station, Urbana, Illinois.
  - Circular 100. Ground Limestone for Acid Soils.







Michigan Agricultural Experiment Station, East Lansing, Michigan.

Circular 11, pp. 79-82 (E.S.R. Vol. 25, 1911, p. 728). Lime for Agricultural Purposes. A.J. Patten and J.A. Jeffery. This is a brief, popular compilation on the subject.

New York Agricultural Experiment Stations.

Technical Bulletin 47, pp. 36, pls. 9. Limestones of New York, with Reference to their Agricultural Use. Geneva, New York.

Circular 7<sup>a</sup>, pp. 16 (E.S.R. Vol. 23, 1910, p. 426). The Relation of Lime to Soil Improvement. E. O. Fippin. Cornell University, Ithaca, N. Y.

Ohio Agricultural Experiment Station, Columbus, Ohio.

Monthly Bulletin 1, (1916) No. 1, pp. 31, 32. The Costs of Obtaining Agricultural Lime at the Clermont and Hamilton Counties Experiment Farms were found to be governed largely by local conditions.

Bulletin 279, (1914) pp. 22. The Maintenance of Fertility - Liming the Land, E. E. Thorne.

Bulletin 220, pp. 660, (E.S.R. Vol. 24 (1911) p. 799) - Reprint of Press Bulletins on the Need of Lime on Southwestern Ohio Soils, and 10 other subjects.

Pennsylvania State Agricultural College, State College, Pennsylvania.

Pamphlet (1911), 7 ed. pp. 8 (E.S.R. 25 (1911) p. 429). Use of Lime on Land. Gives directions regarding the use of lime on land and a list of dealers in agricultural lime, ground limestone, and fertilizers in Pennsylvania.

Bulletin 61, pp. 170, figs. 2, Map 1 (E.S.R. Vol. 12 (1900-01) p. 627). The Use of Lime Upon Agricultural Soils. W. Freare. (Copy)

"This is a detailed discussion, based upon investigations at the Pennsylvania Station and elsewhere, of the agricultural uses of lime; the limestones of Pennsylvania; the burning, slaking and quality of different kinds of lime; the functions of lime in plants and soils; the influence of liming upon soils and the relative value of magnesian limestones; and methods of liming. . . . An appendix gives analyses of Pennsylvania limestones compiled from various sources".

Virginia Agricultural Experiment Station, Blacksburg, Virginia.

Bulletin 187, pp. 3-47, figs. 23 (E.S.R. Vol. 23 (1910) p. 325). Lime for Virginia Farms. W. B. Ellett. This bulletin describes the general principles of liming, methods which may be properly employed under Virginia conditions, methods of constructing lime kilns and burning lime, machinery for crushing limestone and applying lime, available sources of supply, and related matters.

Washington State Agricultural Station, Pullman, Washington.

Bulletin 88 (1909) pp. 8-24, figs. 10 (E.S.R. Vol. 21, (1907-1908) p. 291). Machinery for Applying Land Plaster. B. Hunter.

"The Method of applying land plaster as a fertilizer in western Oregon and western Washington is described, the general practice being to distribute by hand, but it is difficult to secure even distribution by this means. The author therefore describes mechanical devices which have been worked out by farmers in the region and which have been used with satisfactory results in the distribution of plaster. "It is hoped that the descriptions given are sufficiently clear to enable any farmer who is reasonably handy with tools to construct, at a nominal cost, an efficient implement for distributing land plaster".

#### OTHER PUBLICATIONS.

Transactions of the Annual Conventions of The National Lime Manufacturers' Association, Fred F. Irvine, Secretary, Chicago, Illinois, (1913) - Contain articles on the subject.







- Transactions of the 11th Annual Convention of the National Lime Manufacturers' Association, pages 41-65, 1913, "Labor Saving in Building and Operating Lime Kilns".
- "Limestone and Lime Industry in Ohio". Geological Survey of Ohio (Columbus, Ohio) Bulletin No. 4. 294 pages, 1906.
- Journal Department of Agriculture, Victoria 6 (1908) No. 9, pp. 528-529, figs. 2. An Effective Lime Spreader, F. E. Lee. This article describes a machine of simple construction which can be drawn by one horse. The axle is geared to a shaft carrying 22 cog wheels, operating small square linked iron pulley chains 6 inches apart which pass through the box containing the powdered lime. As the machine moves forward the lime is drawn out by the links and is claimed to be uniformly distributed on the land.
- Journal Department of Agriculture, Western Australia 16 (1908) No. 2, pp. 130-134. Lime and its Relation to Agriculture. P. G. Wicken. This article briefly describes burning lime, different forms of lime, and methods of application adapted to conditions in Western Australia.
- Maschinen Zeitung, 4 (1906) No. 17, pp. 200, 201, figs. 3. A New Fertilizer Spreading Machine. "In the operation of the usual machine in which the fertilizer is forced by a roller through holes in the bottom of the receptacle a serious difficulty is often experienced by clogging, due to excessive moisture in the fertilizer. To obviate such trouble and to properly disintegrate the material an apparatus has been devised in which "The bottom of the receptacle is formed of two peculiar spring brushes whose ends press upon a roller rotating between them. The roller is provided with projections arranged in a spiral, and when in operation these projections strike the brushes, thus disintegrating the fertilizer and allowing it to escape through the triangle-shaped orifices caused by the opening of the springs forming the brush. The volume of fertilizer to be distributed is varied by changing the number of revolutions of the roller, which is connected to the wheels of the machine by interchangeable gearing".
- West Virginia Geological Survey (Pub.), 3 (1905), pp. 312-422, 11 plates, 6 figs. The Limestone and Lime Industry of West Virginia. G. R. Grimsley. This report contains chapters on distribution and properties of lime in minerals and rocks, the limestones of West Virginia, technology of lime manufacture, and the use of limestone and lime.
- Journal Board of Agriculture (London), 12 (1905), No. 7, pp. 400-406--or Trinidad Botanical Department Bulletin, Misc. Information, 1906, No. 49, pp. 18-22. The Use of Lime in Agriculture. D. A. Gilchrist. A summary of available information regarding sources of supply, methods of application, and action of lime in the soil, considered mainly from the British standpoint.
- Directory of Cement, Gypsum, and Lime Manufacturers, 1916 edition. Address 538 South Clark Street, Chicago, Illinois.
- Cements, Limes, and Plasters; Their Materials, Manufacture and Properties. By E. C. Eckel. John Wiley & Sons, New York, Publishers, 1905, 712 pages, illustrated - Part 2, "Limes:" Composition, Origin, and General Characters of Limestones; Lime-burning; Composition and Properties of Limes; Hydrated Lime: Its Preparation and Properties; Manufacture and Properties of Lime-sand brick, pages 88 to 148, inc. figures 19 to 26 inc. Many references given of state publications, etc.

NOTE: For manufacturers of lime and hydrated lime and for engineers and contractors of lime plants, consult the various commercial directories and the advertisements in the current engineering periodicals.

Consult also the following files:

Proceedings American Society of Testing Engineers.  
Proceedings Metallurgical and Chemical Engineers.  
Journal of Industrial and Engineering Chemistry.







PARTIAL LIST OF ENGINEERS OR CONTRACTORS OF LIME MANUFACTURING PLANTS.

Edwin C. Eckel, Engineer and Geologist, 1030 Munsey Bldg., Washington, D. C.  
(Examinations and Reports on Cement Materials, etc.)

Richard K. Meade, Chemical, Mechanical, and Industrial Engineer, 202 North  
Calvert St., Baltimore, Md.- (plans and specifications for improving  
old plants and construction of new plants. - Portland cement, lime,  
plaster.)

Henry S. Spackman Engineering Co., New York. - (Designs of Rotating Lime  
Kilns and Plants, etc.)

E. Schmatolla, 150 Nassau St., New York - (Designer and contractor of lime  
plants.)

Hunt Engineering Co., Chicago - (Designers and contractors of plants, etc.)

A. V. Bleining, Engineer, care of the U. S. Bureau of Standards, Washington,  
D. C. (Designer, etc.

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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

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HISTORY OF DEVELOPMENT OF FARM MACHINERY  
(A Partial List of References)

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U. S. DEPARTMENT OF AGRICULTURE

- | <u>Year</u> | <u>Patent Office Reports.</u>                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1856        | Implements and Tools, pp. 452-454.                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1859        | English Plows and Plowing, Henry F. French, pp. 239-260.                                                                                                                                                                                                                                                                                                                                                                                    |
|             | <u>Reports of Commissioner of Agriculture.</u>                                                                                                                                                                                                                                                                                                                                                                                              |
| 1862        | Farm Implements and Machinery, J. J. Thomas, pp. 410-423.<br>Illustrates and describes tillage, seeding, cultivating<br>and harvesting machinery.                                                                                                                                                                                                                                                                                           |
| 1863        | Agricultural Machinery, M. L. Dunlap, pp. 416-435.                                                                                                                                                                                                                                                                                                                                                                                          |
| 1866        | Improved Farm Implements, S. Edwards Todd, Pp. 225-288.<br>Illustrates and describes tillage, seeding, haying, threshing<br>and miscellaneous machinery. Compares rate of doing work at<br>earlier date with 1866.                                                                                                                                                                                                                          |
| 1867        | History of American Inventions for Cultivation by Steam, J.<br>Brainard, pp. 253-263. Illustrated. Steam Cultivation,<br>D. S. Curtis, pp. 263-278.                                                                                                                                                                                                                                                                                         |
| 1868        | The History of the Plow, D.S. Curtiss, pp. 494-496.                                                                                                                                                                                                                                                                                                                                                                                         |
| 1869        | The American Steam Plow, D.S. Curtiss, pp. 305-315.<br>Historical. Illustrated.                                                                                                                                                                                                                                                                                                                                                             |
| 1869        | Recent Progress in Steam Culture, D.S. Curtiss, pp. 296-305. Illustrated.                                                                                                                                                                                                                                                                                                                                                                   |
| 1869        | Agricultural Patents of the Year, pp. 315-334. Write-up of various<br>kinds of farm machines. Illustrated.                                                                                                                                                                                                                                                                                                                                  |
| 1870        | Agricultural Implements and Machines, Ancient and Modern, pp. 392-452.<br>Steam plow. Harvesting wheat in California with header, etc.<br>Illustrated. (A digest of the history of grain drills and corn<br>planters is contained in Information Series #53 and one on<br>Cultivators in Information Series #52, copies of which can be<br>had from The Division of Agricultural Engineering, Bureau of<br>Public Roads, Washington, D. C.) |
| 1871        | Agricultural Patents of 1871, pp. 211-218. Illustrated.                                                                                                                                                                                                                                                                                                                                                                                     |







Year

- 1872 Tractors, pp. 32, 99, 302, 321, 378 and 517. History of steam tractors.
- 1872 A Hundred Years' Progress, Charles L. Flint, pp. 274-304.
- 1874 Steam Plowing, p. 281.
- 1874 Modern Farming in America, Augustin L. Taveau, pp. 280-294.

Yearbooks.

- 1896 Improvements in Wheat Culture. Describes development of machinery used in wheat culture.
- 1899 Progress of Agriculture in the United States. Implements and Machines. pp. 314-320.

Office of Experiment Stations.

- 1902 The Evolution of Reaping Machines, Merritt Finley Miller, Bulletin 103. Illustrates and describes hand reapers, early English machines, American machines; reapers, harvesters (binders and headers) and mowers. Gives list of references on pp. 42 and 43.
- 1907 Corn Harvesting Machinery, C. D. Zintheo. Bulletin 173. History of corn harvesting machinery. Illustrated.
- 1907 Corn Harvesting Machinery, C. J. Zintheo. Farmers' Bulletin 303. Issued August 8, 1907. (Condensed form of O.E.S. Bulletin 173, issued January 4, 1907.)

U. S. DEPARTMENT OF COMMERCE.

Bureau of the Census.

- 1860 (8th Census - preliminary report) View of the condition and progress of agriculture in the United States. Refers to "results of mechanical skill" as well as production of crops. (A digest of this report is contained in Information Series No. 48, a copy of which can be secured from the Division of Agricultural Engineering, Bureau of Public Roads, Washington, D. C. )
- 1860 Progress of Invention in Threshing Instruments, pp. 90-99. Gives dates of inventions, describes tests in France with American machines, etc.
- 1860 (8th Census - Vol. on "Agriculture.") Invention of farm machinery, pp. X-XXIX, and 235.
- 1880 (10th Census - Vol. on "Agriculture.") History of agriculture, Brewer, p. 131.
- 1900 (12th Census - Vol. 10, pt. 4) Introduction, pp. X-XXIV; and 352 and 364.







Year.U. S. DEPARTMENT OF LABOR.

- 1900 (13th Annual Report - 2 volumes) Time necessary to harvest crops of 1900 compared with hand implements in use 75 years before.  
H. W. Quaintance.

STATE PUBLICATIONS.Massachusetts.

- 1854 (1st Annual Report) History of Agriculture in Massachusetts, pp.1-117.  
1873 (20th Annual Report) A hundred years progress (of American Agriculture) pp.11-64.  
1888 (36th Annual Report) American Agriculture, pp. 308-328.

Ohio.

- 1852 Report of Board of Agriculture.  
1869 Report of Board of Agriculture.

BOOKS.

- 1733 The Horse Hoeing Husbandry, Jethro Tull, (printed by author, London. Supplemented in 1736. 3rd edition in 1751) Describes method of introducing a sort of vineyard culture into corn fields to increase their product and diminish expense.  
1797 History of inventions and discoveries, Prof. John Beckman - (London) Early history of windmills.  
1810 Agricultural Mechanism, Capt. Thomas Williamson, (London)  
1811 A History of British Implements and Machinery Applicable to Agriculture, Wm. Lester, (Longman, Hurst, Reese, Orme and Brown)  
1829 The Horse Hoeing Husbandry, or a Treatise on the Principles of Tillage and Vegetation, Jethro Tull, (W. Corbett, London) Contains additional data giving results of experiments by Mr. Corbett.  
1843 Implements of Agriculture, J. Allen Ransome (London) Describes Meikle's threshing machine.  
1849 Short Inquiry into the History of Agriculture in Ancient, Medieval and Modern Times, C. W. Hoskyns, (London)  
1852-3 Rudimentary treatise on Agricultural Engineering, G. H. Andrews, (J. Weale, London)







Year.

- 1854 Farm Implements and Principles of Their Construction and Use, J. J. Thomas, (Harper & Bros., New York) Later editions in 1869, 1879 and 1886.
- 1858 The Book of Farm Implements and Machines, James Slight and R. Scott Burn, (William Blackwood & Sons, Edinburgh)
- 1869 Farm Implements and Farm Machinery, J. J. Thomas, (Orange Judd Co., New York)
- 1875 American Cyclopedia, Vol. XII, p. 16. Mowing and reaping machines.
- 1885 Farm Engineering, John Scott. (Crosby Lockwood & Co., London)
- 1886 Digest of Agricultural Implements Patented in the United States from 1789 to July, 1881, James T. Allen, U. S. Patent Office, (J. C. Van Arx, New York)
- 1894 American Agricultural Implements, Robert L. Ardrey, (Chicago)  
A review of invention and development of the agricultural implement industry of the U. S.
- 1895 One Hundred Years of American Commerce, C. W. Depew, (New York)  
Vol. II, p. 352. Chapter on agricultural machinery and implements, by E. M. Fowler.
- 1895 Johnson's Universal Encyclopedia, Vol. VII, p. 17.
- 1900 International Cyclopedia, Vol. XII, p. 458.
- 1907 Cyclopedia of American Agricultura, L. H. Bailey, Vol. 1, pp. 162-217, and 387-398 (Macmillan & Co., New York)
- 1908 Farm Machinery and Farm Motors, J. B. Davidson and L. W. Chase, (Orange Judd Co., New York) Contains historical information on various farm machines.
- 1924 A Popular History of American Invention. "Farming by Machine", by M. C. Horine, Vol. II, pp. 246-309. (Charles Scribner's Sons, London) History of tillage, planting and harvesting machinery, Illustrated.
- Chambers' Encyclopedia. Article on reaping.
- Encyclopedia Britannica. Article on agriculture.







Year.MISCELLANEOUS

- Quarterly Journal of Economics, Vol. XX, pp.259-278. Agricultural development of the West during the Civil War.
- 1903 Deut. Landw. Press V. 30, Pp. 135-138, History of the development of the plow during 5,000 years; A. Laacke.
- 1904 Publications American Economic Association (November) Vol. 5, No. 4, 3rd series. The influence of farm machinery on production and labor, H. W. Quaintance.
- 1910 Arb. Deut. Landw. Gesell, pp. VIII and 436. The development of agricultural machinery in Germany, G.Fisher et al.
- 1925 The American Thresherman (February) Vol. XXVII, No. 10, p.9. History of the development of the threshing machine.
- 1925 Agricultural Engineering (April) Vol. 6, No. 4, pp. 76-79. The development of the track type tractor, Pliny E. Holt.
- 1925 History of Agriculture in the Northern United States by Bidwell and Falconer - Carnegie Institute of Washington, D. C.







U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING.

Information Series No. 15

*Void.*  
*old*  
*not up to date*  
April, 1916.

BELTING

TRANSACTIONS, AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

- 1880, Vol. 2, "Paper on Belting", by Nagel and Webber.  
1882, " 4, " " " " Webber.  
1884, " 6, " " " " Hugo.  
1885, " 7, " " " " Lanza and Lewis.  
1886, " 8, " " " " Webber.  
1886, " 8, "Article on Belt Testing", by Wilfred Lewis, based on experiments under direction of J. Sellers Bancroft at works of Wm. Sellers & Company.  
1893, Vol. 15, "Notes on Belting", by Taylor.  
1898, " 20, "Formulas for Belts", by Wm. S. Aldrich.  
1905, " 27, "Belt Creep", by Prof. Bird.  
1909, " 31, "The Transmission of Power by Leather Belting", by Carl G. Barth. Conclusions based principally on the experiments of Lewis and Bancroft (TJl. A7)

PROCEEDINGS OF THE NORTHWESTERN RAILWAY CLUB.

In a paper by J. J. Flather is given a chart showing horsepower transmitted by leather belts per inch of width at 5,400 feet per minute and for cemented belts at 6,300 feet per minute. This chart is reproduced in No. 7 Supplement to Machinery, March 1900.

PROCEEDINGS OF THE ASSOCIATION OF ENGINEERS IN CHARGE.

Vol. X, No. 3, Session 1904-05. The St. Bride's Foundation Institute, Bride Lane, Fleet St., London, E. C. "A Paper on Belt Engineering", by John Tullis. Read before the Association on February 8, 1904.5 (TJl100, H85)

ENGINEERING AND CONTRACTING, December 22, 1915, page 481.

A chart for calculating for different materials and belt widths the required number of piles of conveyor belts. (Standard rubber conveyor belts.)

PUBLICATIONS ON BELTING

"A Treatise on Machine Belting", by J. B. Hoyt & Company, New York, 6th Edition 1871, 34 page pamphlet 6" x 4". Includes a table of relative values (per square inch pulley contact) of leather, rubber, gutta percha, and canvas belting for driving machinery; the comparative surface value of pulley, etc. (TJl100. H86)



| Year | Author                    | Title                                                                          |
|------|---------------------------|--------------------------------------------------------------------------------|
| 1902 | Carl G. Barth             | Conclusions based principally on the experiments of Lewis and Hancock (Tl. 47) |
| 1902 | "                         | 31, "The Transmission of Power by Leather Belting", by                         |
| 1905 | "                         | 27, "Belt Crops", by Prof. Bird.                                               |
| 1906 | "                         | 20, "Formulas for Belts", by Wm. S. Aldrich.                                   |
| 1906 | Vol. 15,                  | "Notes on Belting", by Taylor.                                                 |
| 1906 | of Wm. Sellers & Company. | experiments under direction of J. Sellers Hancock at works                     |
| 1886 | "                         | 8, "Article on Belt Testing", by Willard Lewis, based on                       |
| 1886 | "                         | 8, Webber.                                                                     |
| 1886 | "                         | 7, Lanna and Lewis.                                                            |
| 1884 | "                         | 6, Huro.                                                                       |
| 1883 | "                         | 4, Webber.                                                                     |
| 1880 | Vol. 3,                   | "Paper on Belting", by Nagel and Webber.                                       |

reproduced in No. 7 Supplement to Machinery, March 1900.  
and for cemented belts at 8,300 feet per minute. This chart is  
mitted by leather belts per inch of width at 8,400 feet per minute  
In a paper by J. J. Fletcher is given a chart showing horsepower trans-

(71100. 485)  
by John Tollis. Read before the Association on February 8, 1904.  
Bride Lane, Fleet St., London, E. C. "A Paper on Belt Engineering."  
Vol. X, No. 3, Session 1904-05. The St. Bride's Foundation Institute.

A chart for calculating for different materials and belt widths the required number of plies of conveyor belts. (Standard Rubber conveyor belts.)

"A Treatise on Machine Belting", by J. B. Hoyt & Company, New York, 6th Edition 1871, 24 page pamphlet 8" x 4". Includes a table of relative values (per square inch pulley contact) of leather, rubber, gutta percha, and canvas belting for driving machinery; the comparative surface value of pulley, etc. (11100, 788)



PUBLICATIONS ON BELTING (Cont'd)

"Formula and Tables for the Horsepower of Leather Belts," by A. F. Nagel, Providence, R. I., 1882, 8 page pamphlet 9" x 5 $\frac{1}{4}$ ". This formula was first announced at the First Regular Meeting of the American Society of Mechanical Engineers of 1881, Hartford, Conn. (TJ1100 N14).

"A Treatise on Belts and Pulleys", by J. Howard Cromwell. Published by John Wiley & Sons, New York, 1885. 7 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ ", 265 pages, 120 figures. Embraces full explanations of fundamental principles; proper disposition of pulleys; rules, formulas, and tables for determining widths of leather and vulcanized-rubber belts and belts running over covered pulleys; strength and proportions of pulleys, drums, etc., together with the principles of the necessary rules for rop-gearing and transmission of power by means of metallic cables. (TJ1100 C94)

"A treatise on the Use of Belting for the Transmission of Power", by John H. Cooper. Published by Edw. Meeks, Philadelphia, 3d Edition 1888. 9 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ ", 400 pages, 92 figures. Quotations are included from the following; Proceedings of the American Society of mechanical Engineers, Vols. 2, 4, 6, 7, and 8, containing respectively papers on belting by Nagel and Webber, Webb, Hugo, Lanza and Lewis, and Webber. (TJ1100 C77)

"Belt Driving", by Halliday, 1894. (TG883, H18)

"Pulley and Belt Transmission", by the Rockwood Mfg. Co., Indianapolis, Ind., 1906. 9" x 6 $\frac{1}{4}$ ", 69 pages, 16 figures. Many tables. Part I. Various kinds of belt drives; their arrangement and materials used in their construction. Part II. Theory of belt driving and practical formulae developed. Part III. Horsepower Tables for Rockwood Paper, Cast iron, wood and pulp pulleys. Part IV is based on the Cornell University Experiments of 1904-05. (TJ1100, RC)

"The Belt Book", by A. Eugene Michel. Published by Cling-Surface Co., Buffalo, N. Y., 5th Edition, 1914, 9" x 6", 93 pages, fully illustrated. A treatise on the scientific care of transmission belts and ropes for service and profit (TJ1104. C64-1914)

"Experimental Engineering", by R. C. Carpenter. Published by John Wiley & Sons, New York. 1904 Edition. "Belt Dynamometers", "Methods of Testing Belts", "The Sibley College Belt Testing Machine", "Directions for Belt Tests", "Form of Log and Reports", pp 235-241. Friction of Cords and Belts - Sliding Friction, pp 173-4 - Horsepower of Belts (table), p 694.

"Mechanics of Engineering", by J. P. Church, 1911 Edition. "Normal Pressure of Belting, Belt on Rough Cylinder, Impending, Slipping, Transmission of Power by Belting or Wire Rope" pp 181-186.



PUBLICATIONS ON BELTING (Cont'd)

"Formulas and Tables for the Horsepower of Leather Belts," by A. F. Nagel, Providence, R. I., 1888, 8 pages pamphlet 9" x 12". This formula was first announced at the first Regular Meeting of the American Society of Mechanical Engineers of 1881, Hartford, Conn. (TJ1100 H14).

"A Treatise on Belts and Pulleys," by J. Howard Cromwell. Published by John Wiley & Sons, New York, 1888. 7 1/2" x 9 1/2", 385 pages, 120 figures. Embraces full explanations of fundamental principles; proper disposition of pulleys; rules, formulas, and tables for determining widths of leather and vulcanized-rubber belts and belts running over covered pulleys; strength and proportions of pulleys, drums, etc., together with the principles of the necessary rules for dog-gearing and transmission of power by means of metallic cables. (TJ1100 C94)

"A Treatise on the Use of Belting for the Transmission of Power," by John H. Cooper. Published by E. S. Meehan, Philadelphia, 2d Edition 1888. 9 1/2" x 6 1/2", 400 pages, 32 figures. Quotations are included from the following: Proceedings of the American Society of Mechanical Engineers, Vols. 8, 4, 5, 6, 7, and 8, containing respectively papers on belting by Nagel and Webster, Webb, Hago, Hanna and Lewis, and Webster. (TJ1100 C97)

"Belt Driving," by Halliday, 1894. (TJ1100 H18)

"Pulley and Belt Transmission," by the Rockwood Mfg. Co., Indianapolis, Ind., 1906. 9" x 6 1/2", 65 pages, 16 figures. Many tables. Part I. Various kinds of belt drives; their arrangement and materials used in their construction. Part II. Theory of belt driving and practical formulas developed. Part III. Horsepower Tables for Rockwood Paper, Cast Iron, wood and vulg. pulleys. Part IV is based on the Cornell University Experiments of 1904-05. (TJ1100, 30)

"The Belt Book," by A. Eugene Michael. Published by Cling-Surface Co., Buffalo, N. Y., 5th Edition, 1914. 9" x 6", 93 pages, fully illustrated. A treatise on the scientific care of transmission belts and tapes for service and profit. (TJ1104, 084-1914)

"Experimental Engineering," by R. C. Carpenter. Published by John Wiley & Sons, New York, 1904 Edition. "Belt Dynamometers," "Methods of Testing Belts," "The Sibley College Belt Testing Machine," "Directions for Belt Tests," "Form of Log and Reports," pp 335-341. Friction of Cords and Belts - Sliding Friction, pp 173-4 - Horsepower of Belts (table), p 694.

"Mechanics of Engineering," by J. P. Church, 1911 Edition. "Normal Pressure of Belting, Belt on Rough Cylinder, Impending, Slipping, Transmission of Power by Belting or Wire Ropes" pp 181-186.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 16.

May, 1916.

FLOATING WATER POWER PLANTS  
U.S. PATENTS

special  
void

CLASS 170 - MOTORS - FLUID - CURRENT.

Sub-Classes:

| Sub-Classes:                                                          | Approx. No.<br>of Patents |
|-----------------------------------------------------------------------|---------------------------|
| 85 Float Water Motor ) Floating Endless                               | 37                        |
| 86 Float Guide or Deflector ) Chain Type                              | 33                        |
| 103 Float Water Motors, Rotary, Transverse Axis ) Floating Horizontal | 37                        |
| 104 Float Guide or Deflector ) Paddle Wheel Type                      | 34                        |
| 113 Float Water Motors, Rotary, Transverse Axis ) Floating Vertical   | 16                        |
| 114 Float Guide or Deflector ) Paddle Wheel Type                      | 11                        |
| 127 Float Water Motors ) Floating Screw                               | 23                        |
| 128 Float Guide or Deflector ) Propeller Type                         | 15                        |
|                                                                       | <u>206</u>                |

LIST OF A FEW PATENTS IN EACH SUB-CLASS

| Sub-<br>Class: | Number    | Date       | Title                  | Patentee and Address                                                                         |
|----------------|-----------|------------|------------------------|----------------------------------------------------------------------------------------------|
| 85             | 327,888   | 11- 6-1885 | Floating Current Motor | Wm. Main, Brooklyn, N.Y., Assignor to The River & Rail Elec. Lgt. Co. of Ohio Co., W. Va.    |
|                | 625,220   | 5-16-1899  | Current Motor          | Levi M. Shaw, Chicago, Ill.                                                                  |
|                | 327,888   | 10- 6-1885 | Floating Current Motor | Wm. Main of Brooklyn, N.Y., Assignor to The River & Rail Elect. Lgt. Co. of Ohio Co., W. Va. |
|                | 625,220   | 5-16-1899  | Current Motor          | Wm. Turner of Wenatchee, Washington.                                                         |
|                | 848,694   | 4- 2-1907  | Water Motor            | Levi M. Shaw, Chicago, Ill.                                                                  |
|                | 1,131,617 | 2- 9-1915  | Current Motor          | Emanuel A. Speegle, Sawtelle, Cal.                                                           |
| 86             | 1,025,002 | 4-30-1912  | " "                    | Jas. H. Martin, Springfield, Mo.                                                             |
|                | 1,002,417 | 9- 5-1911  | " "                    | Chas. Arthur Mason, Seattle, Wash.                                                           |
|                | 1,156,692 | 10-12-1915 | Water Motor            | J. W. Kinney, Goldcreek, Mont.                                                               |
| 128            | 969,794   | 9-13-1910  | Current Motor          | Chas. T. J. Miner, Kansas City, Mo.                                                          |
|                | 966,042   | 8- 2-1910  | Rotary Current Motor   | Edgar A. McClury, Dayton, Wash.                                                              |
|                | 1,111,722 | 9-22-1914  | Water Motor            | J. H. Sheahan, Freeport, Ill.                                                                |
| 127            | 1,071,748 | 9- 2-1913  | Current Motor          | J. W. Ingison, Kenmore, N. Dak.                                                              |
|                | 1,147,658 | 7-20-1915  | Water Motor            | Jno. M. Stukes, San Antonio, Texas.                                                          |
| 113            | 1,092,403 | 4- 7-1914  | Steam Motor            | Chas. Schoenfeld, Canton, Ohio.                                                              |
|                | 642,935   | 2- 6-1900  | Current Motor          | Robt. Salter Theall, Ft. Pierre, S. Dak.                                                     |
| 114            | 949,747   | 2-15-1910  | Current Motor          | Jas. W. Myers, Robinson, Ill.                                                                |
|                |           |            |                        | Assignor to Myers Motor Co. a corporation of Illinois.                                       |
|                | 1,081,867 | 12-16-1913 | Current Motor          | Geo. E. C. Rousseau & Frank Gregory, Sacramento, Calif.                                      |



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF ENTOMOLOGICAL RESEARCH  
DIVISION OF AGRICULTURAL MECHANICS

Information Series No. 16.

FLUENT WATER MOTOR PATENTS  
U.S. PATENTS

CLASS 170 - MOTOR - FLUID - CURRENT.

| Patent No. | Patentee                                       | Type           |
|------------|------------------------------------------------|----------------|
| 128        | 128 Fluid Guide or Deflector                   | Propeller Type |
| 127        | 127 Fluid Water Motor                          | Fluid Guide    |
| 124        | 124 Fluid Guide or Deflector                   | Fluid Guide    |
| 115        | 115 Fluid Water Motor, Rotary, Transverse Axis | Fluid Guide    |
| 104        | 104 Fluid Guide or Deflector                   | Fluid Guide    |
| 103        | 103 Fluid Water Motor, Rotary, Transverse Axis | Fluid Guide    |
| 82         | 82 Fluid Guide or Deflector                    | Fluid Guide    |
| 81         | 81 Fluid Water Motor                           | Fluid Guide    |

LIST OF A PATENT IN EACH SUB-CLASS

| Patent No. | Patentee  | Type       |
|------------|-----------|------------|
| 1,081,867  | 1,081,867 | 12-15-1912 |
| 114        | 114       | 8-15-1910  |
| 113        | 113       | 8-15-1910  |
| 112        | 112       | 8-15-1910  |
| 111        | 111       | 8-15-1910  |
| 110        | 110       | 8-15-1910  |
| 109        | 109       | 8-15-1910  |
| 108        | 108       | 8-15-1910  |
| 107        | 107       | 8-15-1910  |
| 106        | 106       | 8-15-1910  |
| 105        | 105       | 8-15-1910  |
| 104        | 104       | 8-15-1910  |
| 103        | 103       | 8-15-1910  |
| 102        | 102       | 8-15-1910  |
| 101        | 101       | 8-15-1910  |
| 100        | 100       | 8-15-1910  |
| 99         | 99        | 8-15-1910  |
| 98         | 98        | 8-15-1910  |
| 97         | 97        | 8-15-1910  |
| 96         | 96        | 8-15-1910  |
| 95         | 95        | 8-15-1910  |
| 94         | 94        | 8-15-1910  |
| 93         | 93        | 8-15-1910  |
| 92         | 92        | 8-15-1910  |
| 91         | 91        | 8-15-1910  |
| 90         | 90        | 8-15-1910  |
| 89         | 89        | 8-15-1910  |
| 88         | 88        | 8-15-1910  |
| 87         | 87        | 8-15-1910  |
| 86         | 86        | 8-15-1910  |
| 85         | 85        | 8-15-1910  |
| 84         | 84        | 8-15-1910  |
| 83         | 83        | 8-15-1910  |
| 82         | 82        | 8-15-1910  |
| 81         | 81        | 8-15-1910  |
| 80         | 80        | 8-15-1910  |
| 79         | 79        | 8-15-1910  |
| 78         | 78        | 8-15-1910  |
| 77         | 77        | 8-15-1910  |
| 76         | 76        | 8-15-1910  |
| 75         | 75        | 8-15-1910  |
| 74         | 74        | 8-15-1910  |
| 73         | 73        | 8-15-1910  |
| 72         | 72        | 8-15-1910  |
| 71         | 71        | 8-15-1910  |
| 70         | 70        | 8-15-1910  |
| 69         | 69        | 8-15-1910  |
| 68         | 68        | 8-15-1910  |
| 67         | 67        | 8-15-1910  |
| 66         | 66        | 8-15-1910  |
| 65         | 65        | 8-15-1910  |
| 64         | 64        | 8-15-1910  |
| 63         | 63        | 8-15-1910  |
| 62         | 62        | 8-15-1910  |
| 61         | 61        | 8-15-1910  |
| 60         | 60        | 8-15-1910  |
| 59         | 59        | 8-15-1910  |
| 58         | 58        | 8-15-1910  |
| 57         | 57        | 8-15-1910  |
| 56         | 56        | 8-15-1910  |
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| 54         | 54        | 8-15-1910  |
| 53         | 53        | 8-15-1910  |
| 52         | 52        | 8-15-1910  |
| 51         | 51        | 8-15-1910  |
| 50         | 50        | 8-15-1910  |
| 49         | 49        | 8-15-1910  |
| 48         | 48        | 8-15-1910  |
| 47         | 47        | 8-15-1910  |
| 46         | 46        | 8-15-1910  |
| 45         | 45        | 8-15-1910  |
| 44         | 44        | 8-15-1910  |
| 43         | 43        | 8-15-1910  |
| 42         | 42        | 8-15-1910  |
| 41         | 41        | 8-15-1910  |
| 40         | 40        | 8-15-1910  |
| 39         | 39        | 8-15-1910  |
| 38         | 38        | 8-15-1910  |
| 37         | 37        | 8-15-1910  |
| 36         | 36        | 8-15-1910  |
| 35         | 35        | 8-15-1910  |
| 34         | 34        | 8-15-1910  |
| 33         | 33        | 8-15-1910  |
| 32         | 32        | 8-15-1910  |
| 31         | 31        | 8-15-1910  |
| 30         | 30        | 8-15-1910  |
| 29         | 29        | 8-15-1910  |
| 28         | 28        | 8-15-1910  |
| 27         | 27        | 8-15-1910  |
| 26         | 26        | 8-15-1910  |
| 25         | 25        | 8-15-1910  |
| 24         | 24        | 8-15-1910  |
| 23         | 23        | 8-15-1910  |
| 22         | 22        | 8-15-1910  |
| 21         | 21        | 8-15-1910  |
| 20         | 20        | 8-15-1910  |
| 19         | 19        | 8-15-1910  |
| 18         | 18        | 8-15-1910  |
| 17         | 17        | 8-15-1910  |
| 16         | 16        | 8-15-1910  |
| 15         | 15        | 8-15-1910  |
| 14         | 14        | 8-15-1910  |
| 13         | 13        | 8-15-1910  |
| 12         | 12        | 8-15-1910  |
| 11         | 11        | 8-15-1910  |
| 10         | 10        | 8-15-1910  |
| 9          | 9         | 8-15-1910  |
| 8          | 8         | 8-15-1910  |
| 7          | 7         | 8-15-1910  |
| 6          | 6         | 8-15-1910  |
| 5          | 5         | 8-15-1910  |
| 4          | 4         | 8-15-1910  |
| 3          | 3         | 8-15-1910  |
| 2          | 2         | 8-15-1910  |
| 1          | 1         | 8-15-1910  |



UNITED STATES DEPARTMENT OF AGRICULTURE

| Sub- : | Class :           | Number :     | Date :          | Title :                               | Patentee and Address : |
|--------|-------------------|--------------|-----------------|---------------------------------------|------------------------|
| 103 :  | 806,249 :         | 12-15-1905 : | Current Motor : | Peter H. Foy, Minneapolis, Minn.      | September 19           |
| :      | 960,876 :         | 6-7-1910 :   | Hydraulic :     | :                                     | :                      |
| :      | :                 | :            | Motor :         | Geo. B. French, Fremont, Nebr.        | :                      |
| :      | 1,024,188 :       | 4-23-1912 :  | Hydraulic :     | :                                     | :                      |
| :      | WIDE TIREN-LABS : | :            | Power Plant :   | Jas. T. Douglass, Kenosha, Wis.       | :                      |
| 104 :  | 796,820 :         | 8-8-1905 :   | Current Motor : | Francis M. Cummings, Lewiston, Idaho. | :                      |
| :      | 938,989 :         | 11-2-1909 :  | Water Motor :   | Clerk J. Duncan, Windber, Pa.         | :                      |
| :      | 1,017,860 :       | 2-20-1912 :  | Water Motor :   | Issac Hill Dungan, Humboldt, Tenn.    | :                      |
| :      | 1,113,440 :       | 10-13-1914 : | Water Wheel :   | Marion Hughes, Shawnee, Okla.         | :                      |

#### FLOATING WHEELS, OR CURRENT WHEELS:

(Taken from Cyclopedia of Civil Engineering, American School of Correspondence, Chicago, 1909, Vol. 8, pp 55 - 57)

"This type is simply an undershot wheel with flat, radial vanes, erected on a scow or barge intended to be anchored in a stream, or mounted on some suitable framework built up from the stream bed. The flat blades are attached to an inner circle, but are not enclosed in shrouds, so that the water has very free entry. As the barge rises and falls with the changes of the stream level, the depth of blade immersion is constant. The efficiency is theoretically a maximum, and equal to 50 per cent, when the peripheral speed of the wheel is one-half the velocity of the current; actually, it rarely reaches 40 per cent. When such a wheel is required to drive stationary machinery--that is, machinery so mounted that it does not following the fluctuations in the surface level--some special device must be employed to insure the required condition of constant depth of paddle immersion. These wheels are extremely simple, but require to be of large size in order to develop even a moderate amount of power."

"Wheels of this type have been used for operating dredges on the river Rhine, Germany; they have also been used to a limited extent, principally for irrigation purposes, in the western part of the United States. One at Fayette Valley, Idaho, was said to be 28 feet in diameter, with 28 paddles, each 16 feet long and 2 1/2 feet wide."

(Taken from Hydraulic Engineering, By Hiscox, The Norman W. Henley Publishing Co., New York City, 1908, pp 229 - 230)

"On streams where wing dams or other barrages can not be made available, a current wheel may be mounted on a float with the blades attached to a chain belt. The float may be guided by piles or anchored to the shore and its power conveyed to a mill on shore by belts or rope drive. Another method of obtaining power from deep-water streams with low velocity may be obtained by hanging a multiblade propeller in a sliding frame in a well on a flat-bottom barge, with its power transmitted by chain and gear. This plan is a useful power for pumping the water from the large streams for irrigation. The facility for lowering the wheel to the mid-depth of a stream, the section of its greatest velocity, and for raising the wheel for mooring the float in safe shallow water, when not in use, are advantages claimed for this method of obtaining temporary power."



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF AGRICULTURAL MECHANICS  
DIVISION OF AGRICULTURAL MECHANICS

Information Series No. 18.

FLUENT WATER POWER PLANTS  
U.S. PATENTS

May 1918

CLASS 170 - MOTORS - FLUID - CURRENT

Approx. No.  
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| 37 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 | 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 | 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 | 1017 | 1018 | 1019 | 1020 | 1021 | 1022 | 1023 | 1024 | 1025 | 1026 | 1027 | 1028 | 1029 | 1030 | 1031 | 1032 | 1033 | 1034 | 1035 | 1036 | 1037 | 1038 | 1039 | 1040 | 1041 | 1042 | 1043 | 1044 | 1045 | 1046 | 1047 | 1048 | 1049 | 1050 | 1051 | 1052 | 1053 | 1054 | 1055 | 1056 | 1057 | 1058 | 1059 | 1060 | 1061 | 1062 | 1063 | 1064 | 1065 | 1066 | 1067 | 1068 | 1069 | 1070 | 1071 | 1072 | 1073 | 1074 | 1075 | 1076 | 1077 | 1078 | 1079 | 1080 | 1081 | 1082 | 1083 | 1084 | 1085 | 1086 | 1087 | 1088 | 1089 | 1090 | 1091 | 1092 | 1093 | 1094 | 1095 | 1096 | 1097 | 1098 | 1099 | 1100 | 1101 | 1102 | 1103 | 1104 | 1105 | 1106 | 1107 | 1108 | 1109 | 1110 | 1111 | 1112 | 1113 | 1114 | 1115 | 1116 | 1117 | 1118 | 1119 | 1120 | 1121 | 1122 | 1123 | 1124 | 1125 | 1126 | 1127 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1135 | 1136 | 1137 | 1138 | 1139 | 1140 | 1141 | 1142 | 1143 | 1144 | 1145 | 1146 | 1147 | 1148 | 1149 | 1150 | 1151 | 1152 | 1153 | 1154 | 1155 | 1156 | 1157 | 1158 | 1159 | 1160 | 1161 | 1162 | 1163 | 1164 | 1165 | 1166 | 1167 | 1168 | 1169 | 1170 | 1171 | 1172 | 1173 | 1174 | 1175 | 1176 | 1177 | 1178 | 1179 | 1180 | 1181 | 1182 | 1183 | 1184 | 1185 | 1186 | 1187 | 1188 | 1189 | 1190 | 1191 | 1192 | 1193 | 1194 | 1195 | 1196 | 1197 | 1198 | 1199 | 1200 | 1201 | 1202 | 1203 | 1204 | 1205 | 1206 | 1207 | 1208 | 1209 | 1210 | 1211 | 1212 | 1213 | 1214 | 1215 | 1216 | 1217 | 1218 | 1219 | 1220 | 1221 | 1222 | 1223 | 1224 | 1225 | 1226 | 1227 | 1228 | 1229 | 1230 | 1231 | 1232 | 1233 | 1234 | 1235 | 1236 | 1237 | 1238 | 1239 | 1240 | 1241 | 1242 | 1243 | 1244 | 1245 | 1246 | 1247 | 1248 | 1249 | 1250 | 1251 | 1252 | 1253 | 1254 | 1255 | 1256 | 1257 | 1258 | 1259 | 1260 | 1261 | 1262 | 1263 | 1264 | 1265 | 1266 | 1267 | 1268 | 1269 | 1270 | 1271 | 1272 | 1273 | 1274 | 1275 | 1276 | 1277 | 1278 | 1279 | 1280 | 1281 | 1282 | 1283 | 1284 | 1285 | 1286 | 1287 | 1288 | 1289 | 1290 | 1291 | 1292 | 1293 | 1294 | 1295 | 1296 | 1297 | 1298 | 1299 | 1300 | 1301 | 1302 | 1303 | 1304 | 1305 | 1306 | 1307 | 1308 | 1309 | 1310 | 1311 | 1312 | 1313 | 1314 | 1315 | 1316 | 1317 | 1318 | 1319 | 1320 | 1321 | 1322 | 1323 | 1324 | 1325 | 1326 | 1327 | 1328 | 1329 | 1330 | 1331 | 1332 | 1333 | 1334 | 1335 | 1336 | 1337 | 1338 | 1339 | 1340 | 1341 | 1342 | 1343 | 1344 | 1345 | 1346 | 1347 | 1348 | 1349 | 1350 | 1351 | 1352 | 1353 | 1354 | 1355 | 1356 | 1357 | 1358 | 1359 | 1360 | 1361 | 1362 | 1363 | 1364 | 1365 | 1366 | 1367 | 1368 | 1369 | 1370 | 1371 | 1372 | 1373 | 1374 | 1375 | 1376 | 1377 | 1378 | 1379 | 1380 | 1381 | 1382 | 1383 | 1384 | 1385 | 1386 | 1387 | 1388 | 1389 | 1390 | 1391 | 1392 | 1393 | 1394 | 1395 | 1396 | 1397 | 1398 | 1399 | 1400 | 1401 | 1402 | 1403 | 1404 | 1405 | 1406 | 1407 | 1408 | 1409 | 1410 | 1411 | 1412 | 1413 | 1414 | 1415 | 1416 | 1417 | 1418 | 1419 | 1420 | 1421 | 1422 | 1423 | 1424 | 1425 | 1426 | 1427 | 1428 | 1429 | 1430 | 1431 | 1432 | 1433 | 1434 | 1435 | 1436 | 1437 | 1438 | 1439 | 1440 | 1441 | 1442 | 1443 | 1444 | 1445 | 1446 | 1447 | 1448 | 1449 | 1450 | 1451 | 1452 | 1453 | 1454 | 1455 | 1456 | 1457 | 1458 | 1459 | 1460 | 1461 | 1462 | 1463 | 1464 | 1465 | 1466 | 1467 | 1468 | 1469 | 1470 | 1471 | 1472 | 1473 | 1474 | 1475 | 1476 | 1477 | 1478 | 1479 | 1480 | 1481 | 1482 | 1483 | 1484 | 1485 | 1486 | 1487 | 1488 | 1489 | 1490 | 1491 | 1492 | 1493 | 1494 | 1495 | 1496 | 1497 | 1498 | 1499 | 1500 | 1501 | 1502 | 1503 | 1504 | 1505 | 1506 | 1507 | 1508 | 1509 | 1510 | 1511 | 1512 | 1513 | 1514 | 1515 | 1516 | 1517 | 1518 | 1519 | 1520 | 1521 | 1522 | 1523 | 1524 | 1525 | 1526 | 1527 | 1528 | 1529 | 1530 | 1531 | 1532 | 1533 | 1534 | 1535 | 1536 | 1537 | 1538 | 1539 | 1540 | 1541 | 1542 | 1543 | 1544 | 1545 | 1546 | 1547 | 1548 | 1549 | 1550 | 1551 | 1552 | 1553 | 1554 | 1555 | 1556 | 1557 | 1558 | 1559 | 1560 | 1561 | 1562 | 1563 | 1564 | 1565 | 1566 | 1567 | 1568 | 1569 | 1570 | 1571 | 1572 | 1573 | 1574 | 1575 | 1576 | 1577 | 1578 | 1579 | 1580 | 1581 | 1582 | 1583 | 1584 | 1585 | 1586 | 1587 | 1588 | 1589 | 1590 | 1591 | 1592 | 1593 | 1594 | 1595 | 1596 | 1597 | 1598 | 1599 | 1600 | 1601 | 1602 | 1603 | 1604 | 1605 | 1606 | 1607 | 1608 | 1609 | 1610</ |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

Information Series - No. 17

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WIDE TIRES--LAWS RELATING THERETO---SIZES OF WHEELS  
COEFFICIENTS OF FRICTION--DRAFT--ETC.

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REFERENCES

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Office of Public Roads and Rural Engineering - Manuscript 1913) "Laws Regulating Width of Tires and Loads of Vehicles on Highways in Different States -- Revised Statutes of 1913" - 17 typewritten pages - New legislation has been passed in a few states since this compilation was made.

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Bulletin 39, (1897) "Effect of Width of Tire on Draft of Farm Wagons".  
Bulletin 52, (1901) "Influence of Height of Wheel on the Draft of Farm Wagons". By T. I. Mairs.

TRANSACTIONS OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Eighth Annual Report 1914 - "Draft of Wagons" By E. B. McCormick - pp 84 - 110. Gives summary of tests of Office of Public Roads including those of 1913.

ENGINEERING AND CONTRACTING

Nov. 6, 1912 issue gives a summary of a paper which contains tabulations of the draft of a number of types of pavements.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS

REPORT OF THE DIVISION OF HIGHWAYS FOR THE YEAR 1915

Information for the year 1915 is given in the following tables:

WITH TABLES RELATING TO THE STATE OF WISCONSIN

CONSTRUCTION OF HIGHWAYS - DEPARTMENTS

Table 1. This table gives a summary of the work done by the State Highway Department during the year 1915. It shows the amount of money expended for the construction of highways, the number of miles of highway constructed, and the number of miles of highway improved.

Table 2. This table gives a summary of the work done by the State Highway Department during the year 1915. It shows the amount of money expended for the construction of highways, the number of miles of highway constructed, and the number of miles of highway improved.

Table 3. This table gives a summary of the work done by the State Highway Department during the year 1915. It shows the amount of money expended for the construction of highways, the number of miles of highway constructed, and the number of miles of highway improved.

Table 4. This table gives a summary of the work done by the State Highway Department during the year 1915. It shows the amount of money expended for the construction of highways, the number of miles of highway constructed, and the number of miles of highway improved.

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## WIDTH OF TIRES

The relation of draft to width of tire is one that depends directly upon the condition of the road surface as well as the size of the load, and cannot be answered without taking into consideration those conditions.

This Office is recommending for earth, gravel, macadam, and similar roadways, the following widths of tires.

| Type of Wagon            | Skein          | Gross Load | Width of Tire |
|--------------------------|----------------|------------|---------------|
| One horse farm wagon     | 2-1/8"- 2-3/8" | 2000 lbs.  | 2"            |
| Light two horse wagon    | 2-1/2"         | 3500 lbs.  | 2-1/2"        |
| Medium two horse wagon   | 2-3/4" - 3"    | 4500 lbs.  | 3"            |
| Standard two horse wagon | 3-1/4"         | 6800 lbs.  | 4"            |
| Heavy two horse wagon    | 3-1/2"         | 7500 lbs.  | 5"            |

The widths shown in this table are selected from two different stand-points; first, that of the weight per lineal inch of width of road roller wheels, so that the load on the finished road will not be greater than that used in making it; and second, based upon the results of the tests made by this Office to determine the effect of width of tire on draft. While these tests are not yet completed, the data available to date indicate that, other conditions being equal, the widths of tires selected will give the minimum depth for the given loads on ordinary earth roads, as well as on improved roads of various types.

For asphalt, madadam, wood block, and similar roads it is usually safe to allow a pressure of from 400# to 450# per inch of tire, in as much as the load per inch of rollers runs from 450# to 650# with an average of perhaps 500#.

The tests conducted by this Office have been made in various localities and under widely varying conditions of road conditions, road surface, grades, and type of animal used for motive power. Eight widths of tire have been used.



TABLE OF DATA

The relation of axle to width of tire is one that demands directly upon the condition of the road surface as well as the size of the load, and cannot be answered without taking into consideration these conditions. The Office is recommending for sand, gravel, macadam, and similar roadways, the following widths of tires:

| Type of Wagon            | Width of Tire   | Weight Load |
|--------------------------|-----------------|-------------|
| One horse farm wagon     | 5-1/2" - 5-3/4" | 2000 lbs.   |
| Light two horse wagon    | 5-1/2"          | 2500 lbs.   |
| Medium two horse wagon   | 5-3/4" - 6"     | 3000 lbs.   |
| Standard two horse wagon | 6" - 6-1/2"     | 3500 lbs.   |
| Heavy two horse wagon    | 6-1/2"          | 4000 lbs.   |

The widths shown in this table are selected from two different standards: first, that of the weight per inch of width of road roller wheels, so that the load on the finished road will not be greater than that used in making it; and second, based upon the capacity of the tires made by this Office to determine the effect of width of tire on draft. While these figures are not yet completed, the data available to date indicate that, other conditions being equal, the widths of tires selected will give the minimum draft for the given loads on ordinary earth roads, as well as on improved roads of various types.

For sand, gravel, wood chips, and similar roads it is usually safe to allow pressure of from 500 to 750 per inch of tire, in as much as the load per inch of rollers runs from 500 to 750 with an average of perhaps 600.

The tests conducted by this Office have been made in various localities and under widely varying conditions of road conditions, road surface, grades and type of animal used for motive power. Eight widths of tire have been



as follows: 1-5/8, 2, 2-1/2, 3, 3-1/2, 4, 5, and 6 inches.

### DIFFERENT SIZES OF WHEELS

If all the conditions are equal, the wagon with the larger wheels should show the lesser draft. However, conditions of road surface, type and lubrication of bearings, size of load as regards capacity of wagon, speed, grade, etc., will probably have more effect on the draft than will the height of wheel.

Highway Construction by Byrne, 5th Edition (1907) p. 452.

There are, however, circumstances which provide limits to the height of the wheels of vehicles. If the radius exceeds the height of that part of the horse to which the traces are attached, the line of traction will be inclined to the horse, and part of the power will be exerted in pressing the wheel against the ground.

Wheels of large diameter do less damage to a road than small ones, and cause less draught for the horses.

With the same load a two-wheeled cart does far more damage than one with four wheels, and this because of their sudden and irregular twisting motion in the trackway.

Umpfenbach recommends the following wheel diameters for vehicles frequenting good roads:

1. For two-wheeled freight-carts, 5 feet 3 inches to 5 feet 9 inches.
2. For four-wheeled freight-wagons, front wheels 3 feet 1 inch, hind wheels 3 feet 9 inches to 4 feet 2 inches.

These diameters should be increased from 6 to 12 inches for traffic on bad roads.

Roads and Pavements by Baker, 1st Edition (1903) p. 22.

Diameter of Wheel. --The rolling resistance varies inversely as some function of the diameter of the wheel, since the larger the wheel the less the force required to lift it over the obstruction or to roll it up the inclination due to the indentation of the surface. Table 3 shows the results obtained by Mr. T. I. Mairs at the Missouri Agricultural Experiment Station, (Missouri Agricultural Experiment Station, Bulletin No. 52. Columbia, 1902.) with three different-sized wheels. The 50-inch represents 44-inch front wheels and 56-inch hind wheels; the 38-inch represents 36-inch front and 40-inch hind wheels; and the 26-inch represents 24-inch front and 28-inch hind wheels. The tires were 6 inches wide. The load was practically  $1\frac{3}{4}$  tons in each case.



as follows: 1-7/8, 2, 2-1/8, 3, 3-1/8, 4, 5, and 6 inches.

MINIMUM SIZE OF WHEELS

It is the intention and usual practice to use wheels which are larger than the axle diameter. The reason for this is that the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be. This is because the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be. This is because the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be.

Highway Construction by Bureau, San Antonio (1937) p. 122.

There are, however, circumstances under which the axle diameter is not constant. It is the intention and usual practice to use wheels which are larger than the axle diameter. The reason for this is that the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be. This is because the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be. This is because the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be.

Roads and Pavements by Bureau, San Antonio (1937) p. 122.

Diagram of Wheel - The rolling resistance varies inversely as the diameter of the wheel. The reason for this is that the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be. This is because the axle diameter is constant, but the wheel diameter varies with the load. The larger the load, the larger the wheel diameter must be.



TABLE 3

## Effect of Size of Wheels on Tractive Resistance

Resistances in Pounds per Ton

| Ref. No. | Description of Road Surface                                        | Mean Diameter of Front and Rear Wheels. |       |       |
|----------|--------------------------------------------------------------------|-----------------------------------------|-------|-------|
|          |                                                                    | 50"                                     | 38"   | 26"   |
| 1        | :Madadam: slightly worn, clean, fair condition                     | : 57                                    | : 61  | : 70  |
| 2        | :Gravel road: dry, sand 1" deep, some loose<br>: Stones.....       | : 84                                    | : 90  | : 110 |
| 3        | :Gravel road: up grade 2.2%, 1/2" wet sand,<br>: frozen below..... | : 123                                   | : 132 | : 173 |
| 4        | :Earth road: dry and hard.....                                     | : 69                                    | : 75  | : 79  |
| 5        | : " " 1/2" sticky mud, frozen below, rough....                     | : 101                                   | : 119 | : 139 |
| 6        | :Timothy and blue-grass sod: dry, grass cut.....                   | : 132                                   | : 145 | : 179 |
| 7        | : " " " " " Wet and spongy.....                                    | : 173                                   | : 203 | : 281 |
| 8        | :Corn-field: flat culture, across rows, dry on<br>: top.....       | : 178                                   | : 201 | : 265 |
| 9        | :Plowed ground: not harrowed, dry and cloddy.....                  | : 252                                   | : 303 | : 374 |
| 10       | : Average value of the tractive power.....                         | : 130                                   | : 148 | : 186 |

## COEFFICIENTS OF FRICTION

Dupuit's Table for the Ratio of Tractive Force to Load.

| Class of Vehicle | Diameter of wheels (in metres) | Width of tires (In metres) | Ratio of Tractive Force to Pressure on |                     |          |
|------------------|--------------------------------|----------------------------|----------------------------------------|---------------------|----------|
|                  |                                |                            | Macadam: Walking: or Trotting          | Paved Roads Walking | Trotting |
| Cart.....        | 1.82                           | .05 (1.97")                | .032                                   | .012                | .028     |
| Rubbish cart:    | 1.85                           | .075 (2.95")               | .031                                   | .0205               | .028     |
| " " :            | 1.89                           | .11 (4.33")                | .03                                    | .0176               | .028     |
| " " :            | 1.90                           | .14 (5.52")                | .03                                    | .0166               | .028     |
| Gig.....         | 1.48                           | .05 (1.97")                | .036                                   | .024                | .034     |
| Carriage....     | 1.96                           | .17 (6.70")                | .029                                   | .0177               | .028     |
| Char-a-banc :    | 1.50                           | .05 (1.97")                | .036                                   | .03                 | .037     |
| " :              | 0.86                           | .05 (1.97")                | .036                                   | .03                 | .037     |
| Coach.....       | 1.5                            | .13 (5.12")                | .029                                   | .016                | .02      |
| " :              | 0.95                           | .13 (5.12")                | .029                                   | .016                | .02      |



TABLE 3

Effect of Size of Wheels on Tractive Resistance

Resistances in Pounds per Ton

| No. | Description of Road Surface                 | Mean Diameter of Wheel | Mean Diameter of Tire |
|-----|---------------------------------------------|------------------------|-----------------------|
| 1   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 2   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 3   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 4   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 5   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 6   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 7   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 8   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 9   | Gravel road, dry, sand 1/2 deep, some loose | 30"                    | 30"                   |
| 10  | Average value of the above                  | 30"                    | 30"                   |

CHARACTERISTICS OF WHEELS

Table 3 gives the results of tractive force tests.

| Class of Vehicle | Width of Wheel (in inches) | Width of Tire (in inches) | Tractive Force (in pounds) | Tractive Force (in tons) |
|------------------|----------------------------|---------------------------|----------------------------|--------------------------|
| Car              | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |
| Tractor          | 1.50                       | 1.50                      | 0.05                       | 0.05                     |



# TRACTIVE EFFORT OR DRAFT

Average Tractive Effort in Pounds per Short Ton on  
Different Grades and Surfaces.\*

| Kind of surface                | : Level : | : 5% Grade : | : 10% Grade |
|--------------------------------|-----------|--------------|-------------|
| Earth firm                     | : 100     | : 200        | : 300       |
| Gravel rolled                  | : 85      | : 185        | : 285       |
| Good ordinary macadam          | : 40      | : 140        | : 240       |
| Granite pavement smooth        | : 35      | : 135        | : 235       |
| Brick pavement, cement grouted | : 28      | : 128        | : 228       |
| Asphalt cold                   | : 25      | : 125        | : 225       |

It is usually assumed that a horse can exert from 100 to 150 pounds effort at a speed of 2½ to 3 miles per hour and can double or even quadruple his effort for short periods--possibly 20% of the time in a 10 hour day. Two horses are not quite as effective working together as alone and efficiency decreases slowly with the number worked together.

Good practice has established five per cent and six per cent as desirable maximum grades and has also sanctioned seven per cent and also eight per cent for short stretches where a less grade would be prohibitive in cost. An ideal maximum grade appears to be four per cent. In France on the national roads three per cent is the maximum grade except in the mountains. Practical Talks on Farm Engineering by R. P. Clarkson (1915).

Doubleday, Page & Co., N. Y. pp. 105-106

In determining the size of tractor needed for any particular work, the following table will be of interest. In reading them, it should be observed that drawbar pull corresponds to the pull on the traces by horses or the pull on the pole by oxen. It is the pull which the tractor will exert through the medium of the drawbar, the bar which couples the tractor to the train it draws after it.

\*This is only a guide table based on combined results of various experiments. Tractive effort varies with conditions of speed, tire width, wheel diameter, moisture and temperature. For a summary of various experiments and results see "Road Making and Maintenance", Thos. Aitken, Appendix I, London, 1907.



REACTIVE EFFORT ON SURFACE

Average Reactive Effort in Pounds per Square Inch on  
Different Grades and Surfaces.

| Kind of surface          | Level | 5% Grade | 10% Grade |
|--------------------------|-------|----------|-----------|
| Hard lime                | 100   | 200      | 300       |
| General polished         | 85    | 185      | 285       |
| Good ordinary concrete   | 80    | 180      | 280       |
| Granite pavement, smooth | 75    | 175      | 275       |
| Brick pavement, smooth   | 70    | 170      | 270       |
| Asphalt                  | 65    | 165      | 265       |

It is generally assumed that a horse can exert  
from 100 to 150 pounds effort at a speed of  
25 to 30 miles per hour, and can double or even  
quadruple his effort for a few minutes. These  
figures are for the horse in a harness. Two  
horses are not better off when working in  
company at a slow and ordinary pace than when  
in with the same number of horses.

Good practice in wheeling has been found to be  
able maximum grades and has also been found to be  
not only for short distances when a horse would be prohibitive in cost.  
In these maximum trials horses to be four per cent. In harness on the  
national roads there you have is the maximum grade except in the mountains.

Practical Tables on Horse Engineering by Dr. F. C. Johnson (1905).

Reprinted, 1905, E. C. N. Y. Co. 107-108.

In determining the value of horses raised for any  
particular work the following table will be of use.  
In general, it should be observed that  
whether the horse is used on the track or  
in harness on the farm, the value is the same  
which the owner will receive through the market or the  
breeder, the horse should be the factor in the sale.  
It shows that:

\*This is only a guide and is based on a number of various  
months. Reactive effort varies with conditions of speed, of weight, of  
distance, nature and resistance, for a number of various experiments and  
results are "Great Horses and Harnesses", Theo. Ashton, Appendix I, London.



## Drawbar Pull Required for a Load of One Ton In Wagon.

|                            | : Good Road | : Gravel | : Sand |
|----------------------------|-------------|----------|--------|
|                            | : lbs.      | : lbs.   | : lbs. |
| On the level               | : 125       | : 250    | : 625  |
| Rise of 1 foot in 100 feet | : 145       | : 270    | : 645  |
| " " 2 " " "                | : 165       | : 290    | : 665  |
| " " 3 " " "                | : 185       | : 310    | : 685  |
| " " 4 " " "                | : 205       | : 330    | : 705  |
| " " 5 " " "                | : 225       | : 350    | : 725  |
| " " 6 " " "                | : 245       | : 370    | : 745  |

Power and The Plow by Ellis &amp; Rumely (1911)

Doubleday Page &amp; Co., N. Y. pp. 311-313.

Horsepower and draft required to pull a 27,000-lb. tractor over various grades and road surfaces at a net speed of 1.9 miles per hour (no allowance for slippage), calculated from actual tests on the same day on level surfaces at speeds of from 1.77 to 1.99 miles per hour:

| Grade                   | : Macadam | : Firm Earth: | : Soft Muddy | : Soft Field  |
|-------------------------|-----------|---------------|--------------|---------------|
|                         | : road    | : Not sticky: | : Road       |               |
| Ft. per mile: per cent: | Draft:    | H.P.:         | Draft:       | H.P.:         |
|                         | Draft:    | H.P.:         | Draft:       | H.P.:         |
| Level                   | : 0       | : 2135:10.82: | 2500:12.67:  | 2650 : 13.43: |
| 53                      | : 1       | : 2405:12.19: | 2770:14.04:  | 2920 : 14.80: |
| 106                     | : 2       | : 2675:13.55: | 3040:15.40:  | 3190 : 16.16: |
| 158                     | : 3       | : 2945:14.92: | 3310:16.77:  | 3460 : 17.53: |
| 211                     | : 4       | : 3215:16.29: | 3580:18.14:  | 3730 : 18.90: |
| 264                     | : 5       | : 3485:17.66: | 3850:19.51:  | 4000 : 20.27: |
| 422                     | : 8       | : 4295:21.76: | 4660:23.61:  | 4810 : 24.37: |
| 528                     | : 10      | : 4835:24.50: | 5200:26.35:  | 5350 : 27.11: |
| 634                     | : 12      | : 5375:27.24: | 5740:29.08:  | 5890 : 29.84: |
| 792                     | : 15      | : 6185:31.34: | 6550:33.19:  | 6700 : 33.95: |

It will be noted that the percentage of variation in draft between different road surfaces is not so great as for wagons; also that the draft ranges from about 160 to 225 pounds per gross ton. These drafts per ton are higher than are usual with wagons, and may be partly ascribed to the greater internal friction. A ton of engine weight pulled about 19 per cent. harder than a ton of wagon and load at the Winnipeg motor contest of 1909. The speed of travel for the tests reported in this table was 1.95 for macadam; 1.93 for firm dirt; 1.77 for soft, muddy road, and 1.67 for the soft field. The tractor pulling this load was designed to run at 2.05 miles per hour on low gear, hence the slippage under the various conditions ranged from







about 5 to 13.5 per cent.. If a constant figure for friction of gearing, etc., were subtracted from the draft per gross ton in each case, and for the better surfaces possibly a trifle more in proportion as the speed increases, the difference in draft due to road surface would be more strongly emphasized. On grades, the friction and ground resistance are constant, for all practical purposes, variation being due to the lift on the tractor alone. In actual pulling, the internal friction would be increased to an undetermined extent, hence possibly 250 pounds of resistance per ton of tractor weight would be none too much to allow on the level in order to estimate the horsepower required to move a tractor over an ordinary road. Each per cent. of grade adds 20 pounds per ton to the resistance. For example: A tractor weighs 8 tons and moves at 2.5 miles per hour up a 4 per cent grade. What power does it take to move it?

$$(8 \times 250) + (8 \times 4 \times 20) \text{ equals } 2640 \text{ pounds.}$$

$$\frac{2640 \times 2.5}{375} \text{ equals } 17.6 \text{ H.P.}$$

Farm Machinery and Farm Motors by Davidson & Chase (1908)

Orange Judd Company, N. Y. pp. 451-452.

Any traction engine has power enough to propel itself over the road and through the fields provided the drive wheels do not slip. Consequently the matter of the wheels adhering to the ground is an important part. Where the road surface is firm there is no difficulty; but in a soft field great trouble is experienced due to the fact that the lugs of the drive wheels tear up the earth and allow the drive wheels to move without moving the engine. It is a common belief that the drive wheel which has the sharpest lug is the one which will adhere to the ground the best. In nearly all cases this is not true, since the lug which is sharp is very apt to cut through the earth, while one which is dull or round and does not have such penetrating effect will pack the earth down and thus make more resistance for itself while passing through the earth. The more weight that can be put on to the drive wheels of an engine the better it will adhere to the ground, providing the surface is firm enough to support the load. This makes the matter of location of the main axles upon the boiler an important factor.

When the boiler is rear-mounted it is obvious that more of the weight is thrown upon the front wheels, which act as a guide, than when the boiler is side-mounted. Hence one would be led to believe that the side-mounted traction engine will have better tractive power than the rear-mounted. It is also indicative of better tractive power when the pivot of the front axle is as far ahead as possible. For this reason some builders are now attaching a frame to the boiler and crowding the front trucks ahead.



# Information 17.

about 5 to 10 per cent. If a constant figure for this  
tion of bearing etc. were subtracted from the total per-  
gross ton in each case, and for the better surface possi-  
ly a trifle more in proportion to the speed increase, the  
difference in draft due to road surface would be more accu-  
ly emphasized. On grades, the friction and ground resistance  
are constant for all practical purposes, variation being due  
to the lift on the tractor alone. In normal rolling, the  
internal friction would be increased to an undetermined ex-  
tent, hence possibly 250 pounds of resistance per ton of weight  
for weight would be more accurate to allow on the level in  
order to estimate the horsepower required to move a tractor  
over an ordinary road. Each pound of grade adds 20 pounds  
per ton to the resistance. For example: A tractor weighs 2  
tons and moves at 5.5 miles per hour up a 4 per cent grade.  
What power does it take to move it?

$$(2 \times 250) \times (4 \times 20) \text{ equals } 2000 \text{ pounds.}$$

$$\frac{2000 \times 5.5}{375} \text{ equals } 29.3 \text{ H.P.}$$

Tractor Machinery and Farm Motors by Davidson & Chase (1908)

Orange Road Company, N. Y. 1914-1921

Any traction engine has power enough to propel itself over  
the road and through the fields provided the drive wheels do  
not slip. Consequently the matter of the wheels adhering to  
the ground is an important factor. Where the road surface is  
firm there is no difficulty, but on a soft field great trouble  
is experienced due to the fact that the logs of the drive wheels  
tear up the earth and allow the drive wheels to move without  
moving the engine. It is a common belief that the drive wheel  
which has the sharpest rim is the one which will adhere to the  
ground the best. In nearly all cases this is not true, since  
the log which is sharp is very apt to cut through the earth,  
while one which is dull or rounded will not have such pen-  
etrating effect will push the earth down and thus make more ad-  
herence for itself while passing through the earth. The more  
weight that can be put on the drive wheels of an engine the  
better it will adhere to the ground, providing the wheels are  
firm enough to support the load. This is the reason of the  
action of the ball rollers upon the better an important factor.  
When the roller is not mounted it is obvious that none of the  
weight is taken upon the front wheels, which act as a guide,  
than when the roller is attached. Hence one would be led  
to believe that the roller-mounted traction engine will have bet-  
ter tractive power than the other. It is not a satisfactory  
of better tractive power than the other. It is not a satisfactory  
way should be possible. For this reason some rollers are now  
carrying a roller to the roller and moving the front wheels ahead.



The following is taken from Highway Construction by Byrne, 5th Edition (1907) pp. 436-438.

The following deductions are from the experiments of M. M. Dupuit and Morin:

1st. The resistance to traction on uniform smooth surfaces is directly proportional to the load, and inversely as the square root of the diameter of the wheels.

2nd. It is independent of the width of the tire when this quantity exceeds 3 or 4 inches.

3d. It is independent of the speed.

4th. On paved surfaces which give rise to constant concussion, it increases with the speed.

5th. Upon soft roads of earth or sand or turf, or roads fresh and thickly gravelled, the resistance to traction is independent of the velocity.

6th. At a walking pace, the resistance is the same, under the same circumstances, for vehicles with springs and for vehicles without springs.

7th. The destruction of the road is, in all cases, greater as the diameter of the wheels is less, and it is greater in vehicles without than with springs.

The comparative ease of draft on various surfaces is largely influenced by the amount of foothold afforded, and it may be doubted if dynamometer experiments, however carefully made, are altogether conclusive. The tractive force is influenced by the diameter of the wheels, the friction of the wheels on the axles, and the speed, as well as by the resistance of the road surface; and these must be all taken into account to obtain accurate results.

On page 437 is given a table of Resistance to Traction on Different Road Surfaces.

Roads and Pavements by Baker, 1st Edition (1903) pp. 30-31.

From a study of the preceding experiments and also others not here described, it is concluded that the average tractive resistance on different road surfaces is about as in Table 9, which is given for use in comparing different roads and pavements.



The following is taken from Highway Construction by Byrne, 1st Edition (1907) pp. 436-438.

The following definitions are from the experiments of M. M. Duguid and Martin:

1st. The resistance to traction on uniform wheels varies as the square root of the diameter of the wheels.

2nd. It is independent of the width of the tire when this quantity exceeds 5 or 6 inches.

3rd. It is independent of the speed.

4th. On paved surfaces which give rise to constant resistance, it increases with the speed.

5th. Upon soft roads of earth or sand or turf, or roads loose and thinly gravelled, the resistance to traction is independent of the velocity.

6th. At a walking pace, the resistance is the same, whether the same circumstances, for vehicles with springs and for vehicles without springs.

7th. The resistance of the road is, in all cases, greater or as the diameter of the wheels is less, and it is greater in vehicles without than with springs.

The comparative ease of draft on various surfaces is largely influenced by the amount of foothold afforded, and it may be doubted if dynamometer experiments, however carefully made, are altogether conclusive. The tractive force is influenced by the diameter of the wheels, the friction of the wheels on the axles, and the speed, as well as by the resistance of the road surface, and these must be all taken into account to obtain accurate results.

On page 437 is given a table of Resistance to Traction on Different

Road Surfaces.

Roads and Pavements by Byrne, 1st Edition (1907) pp. 30-31.

From a study of the preceding experiments and also others not here described, it is concluded that the average tractive resistance on different road surfaces is about as in Table 2, which is given for use in comparing different roads and pavements.



TABLE 9.

Standard Tractive Resistance of Different Roads  
and pavements.

| Ref.<br>No. | Kinds of Road Surface.                    | Tractive Resistance. |                   |
|-------------|-------------------------------------------|----------------------|-------------------|
|             |                                           | Pounds per Ton.      | In Terms of Load. |
| 1           | Asphalt--artificial sheet.....            | 30- 70               | : 1/67 - 1/30     |
| 2           | Brick.....                                | 15- 40               | : 1/133 - 1/50    |
| 3           | Cobble stones.....                        | 50-100               | : 1/40 - 1/20     |
| 4           | Earth roads--ordinary condi-<br>tion..... | 50-200               | : 1/40 - 1/10     |
| 5           | Gravel roads.....                         | 50-100               | : 1/40 - 1/20     |
| 6           | Macadam.....                              | 20-100               | : 1/100 - 1/20    |
| 7           | Plank road.....                           | 30- 50               | : 1/67 - 1/40     |
| 8           | Sand--ordinary condition.....             | 100-200              | : 1/20 - 1/10     |
| 9           | Stone block.....                          | 30- 80               | : 1/67 - 1/25     |
| 10          | Steel wheelway.....                       | 15- 40               | : 1/133 - 1/50    |
| 11          | Wood block--rectangular.....              | 30-50                | : 1/67 - 1/40     |
| 12          | " " cylindrical.....                      | 40- 80               | : 1/50 - 1/25     |



TABLE 2

Standard Traffic Resistance of Different Roads and Pavements.

| No. | Kind of Road Surface.      | Pounds per Ton. | Relative Resistance. |
|-----|----------------------------|-----------------|----------------------|
| 1   | Asphalt - artificial stone | 50-70           | 1.50 - 1.70          |
| 2   | Bitum.                     | 15-40           | 1.25 - 1.50          |
| 3   | Gravel stone               | 50-100          | 1.40 - 1.60          |
| 4   | Gravel roads - ordinary    | 50-200          | 1.40 - 1.60          |
| 5   | Gravel roads               | 50-100          | 1.40 - 1.60          |
| 6   | Macadam                    | 50-100          | 1.40 - 1.60          |
| 7   | Flint road                 | 30-50           | 1.20 - 1.40          |
| 8   | Sand - ordinary            | 100-200         | 1.50 - 1.75          |
| 9   | Stone block                | 30-80           | 1.25 - 1.50          |
| 10  | Steel wheelfway            | 15-40           | 1.50 - 1.70          |
| 11  | Wood block - rectangular   | 30-50           | 1.50 - 1.70          |
| 12  | " " cylindrical            | 40-80           | 1.50 - 1.75          |



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- No. 963-Tractor Experience in Illinois.
- No. 966-Simple Hog-Breeding Crate
- \*No. 970-Sweet Potato Storage
- No. 974-Clearing Land.
- No. 976-Cooling Milk and Cream on the Farm.
- No. 978-Handling Barn Yard Manure in Eastern Pennsylvania.
- No. 987-Labor Saving Practices in Hay Making Shown Pictorially.
- No. 991-The Efficient Operation of Thrashing Machines
- No. 992-The Use of Machinery in Cutting Corn
- No. 1004-The Gas Tractor in Eastern Farming
- No. 1009-Hay Stackers
- No. 1013-Practical Hints on Running a Gas Engine.
- No. 1017-Cattle Scab and Methods of Control and Eradication.
- No. 1023-Machinery for Cutting Firewood.
- No. 1032-Operating a Cooperation Motor Truck Route.
- No. 1035-The Farm Tractor in the Dakotas.
- No. 1036-Care and Repair of Farm Implements - Grain Separators.
- No. 1045-Laying out Fields for Tractor Plowing
- No. 1049-Baling Hay
- No. 1057-Cattle Fever Ticks and Methods of Eradication.
- No. 1078-Harvesting and Storing Ice on the Farm.
- \*No. 1087-Beautifying the Farmstead. 15¢
- No. 1091-Protection of Potatoes from Cold in Transit.
- No. 1093-Influence of the Tractor on the Use of Horses.
- No. 1097-The Stable Fly
- No. 1098-Dusting Machinery for Cotton Boll Weevil Control.
- No. 1107-Brood Coops and Appliances.
- No. 1113-Poultry Houses.
- No. 1131-Tile Trenching Machinery.
- No. 1132-Planning the Farmstead
- No. 1157-Water and Mildew Proofing of Cotton Duck.
- No. 1173-Plans of Rural Community Buildings.



INDEX: SUBJECTS (Continued)

- No. 113-Plans of Rural Community Buildings.
- No. 114-Water and Sewer Systems of Cotton Ginn.
- No. 115-Planning the Farmstead.
- No. 116-Using Farming Machinery.
- No. 117-Feeding Horses.
- No. 118-Feeding Cattle and Hogs.
- No. 119-Feeding Poultry.
- No. 120-Feeding Swine.
- No. 121-Feeding Sheep.
- No. 122-Feeding Fish.
- No. 123-Feeding Rabbits.
- No. 124-Feeding Guinea Pigs.
- No. 125-Feeding Birds.
- No. 126-Feeding Insects.
- No. 127-Feeding Fish.
- No. 128-Feeding Rabbits.
- No. 129-Feeding Guinea Pigs.
- No. 130-Feeding Birds.
- No. 131-Feeding Insects.
- No. 132-Feeding Fish.
- No. 133-Feeding Rabbits.
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- No. 142-Feeding Fish.
- No. 143-Feeding Rabbits.
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- No. 145-Feeding Birds.
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- No. 193-Feeding Rabbits.
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- No. 196-Feeding Insects.
- No. 197-Feeding Fish.
- No. 198-Feeding Rabbits.
- No. 199-Feeding Guinea Pigs.
- No. 200-Feeding Birds.



## FARMERS' BULLETINS (Continued)

- No. 1174 One-Register Furnaces
- No. 1177 Care and Improvement of Farm Woods
- No. 1178 Tree Surgery
- \*No. 1194 Operating a Home Heating Plant 5¢
- No. 1201 Motor Trucks on Eastern Farms
- \*No. 1227 Sewage and Sewerage of Farm Homes. 5¢
- No. 1230 Chimneys and Fireplaces
- No. 1278 Tractors on Southern Farms

## DEPARTMENT BULLETINS.

- No. 98 The Application of Refrigeration to the Handling of Milk. Price 10¢
- \*No. 118 Experiments in the Destruction of Fly Larvae in Horse Manure. Price 10¢
- \*No. 131 Repellents for Protecting Animals from the Attacks of Flies. Price 5¢
- \*No. 163 A Field Test for Lime-Sulphur Dipping Baths. Price 5¢
- No. 200 A Maggot Trap in Practical Use: An Experiment in House-Fly Control Price 5¢
- \*No. 230 Oil-mixed Portland Cement Concrete. Price 10¢
- \*No. 245 Further Experiments in the Destruction of Fly Larvae in Horse Manure Price 5¢
- No. 277 Cotton Warehouse Construction. Price 10¢
- No. 379 Dust Explosions and Fires in Grain Separators in the Pacific Northwest. Price 10¢
- \*No. 412 The Normal Day's Work of Farm Implements, Workmen, and Crews in Western New York. Price 5¢
- \*No. 420 Cooling Hot-bottled Pasteurized Milk by Forced Air. Price 10¢
- \*No. 423 Labor Requirements of Dairy Farms as Influenced by Milking Machines Price 5¢
- \*No. 494 A Humidifier for Lemon Curing Rooms. Price 5¢
- \*No. 509 The Theory of Drying and its Application to the New Humidity-regulated and Recirculating Dry Kiln. Price 5¢
- \*No. 510 Timber Storage Conditions in the Eastern and Southern States with Reference to Decay Problems. Price 20¢
- \*No. 552 The Seasoning of Wood. Price 10¢
- No. 556 Mechanical Properties of Woods Grown in the United States. Price 10¢
- No. 527 Some Exercise in Farm Handicraft for Rural Schools. Price 10¢
- No. 605 Lumber Used in the Manufacture of Wooden Products. Price 5¢
- No. 607 Tests of the Absorption and Penetration of Coal Tar and Creosote in Loblolly Pine. Price 15¢
- No. 676 The Relation of the Shrinkage and Strength Properties of Wood to its Specific Gravity. Price 10¢
- No. 681 Grain Dust Explosions.
- No. 729 Suitable Storage Conditions for Certain Food Products. Price 10¢
- \*No. 736 The Open Shed Compared with the Closed Barn for Dairy Cows. Price 5¢
- No. 744 Cooling Milk and Storing and Shipping it at Low Temperature. Price 10¢
- No. 753 The Use of Wood for Fuel. Price 10¢
- \*No. 789 Notes on Grain Pressures in Storage Bins. Price 5¢
- No. 801 Construction and Fire Protection of Cotton Warehouses. Price 50¢
- \*No. 825 Rural Community Buildings in the United States. Price 10¢
- No. 849 City Milk Plants. Price 10¢
- \*No. 864 A Peach Sizing Machine. Price 5¢
- \*No. 872 Insect Control in Flour Mills. Price 15¢
- \*No. 890 Milk-Plant Equipment. Price 15¢
- \*No. 894 Manual of Designs and Installation of Forest Service Water Spray Dry Kiln. Price 10¢
- \*No. 897 Weight Variation of Package Foods. Price 5¢
- \*No. 898 Turpentine. Price 15¢
- \*No. 910 Experience of Eastern Farmers with Motor Trucks. 10¢



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DEPARTMENT BULLETINS (Continued)

- 931 Corn Belt Farmers' Experiment with Motor Trucks
- 997 The Cost and Utilization of Power on Farms where tractors are owned.

DEPARTMENT CIRCULARS

- No. 64 How Lumber is Graded. Price 10¢
- No. 94 T N T as a Blasting Explosive
- No. 98 The Installation of Dust-collecting Fans on Thrashing Machines  
price 5¢
- No. 191 The Use of Explosives in Blasting Stumps.
- No. 212 The Manufacture and Sale of Farm Equipment, 1920.

YEARBOOK SEPARATES

- \*No. 634 Clean Water and How to Get it on the Farm. Price 10¢
- \*No. 646 Selection of Household Equipment. Price 5¢
- \*No. 712 Sewage Disposal on the Farm. Price 5¢
- No. 770 Electric Light and Power from Small Streams. Price 5¢
- No. 789 Housing the Worker on the Farm. Price 5¢
- \*No. 799 Electric Light and Power on the Farm Home.
- \*No. 814 Home Production of Lime by the Farmer. Price 5¢
- No. 823 Trapping on the Farm. Price 5¢
- \*No. 824 Securing a Dry Cellar. Price 10¢
- \*No. 825 The Horsepower Problem on the Farm. Price 5¢

OFFICE OF THE SECRETARY

- \*Rep. No. 104 Needs of Farm Women. Compiled in the Office of Information.  
Obtainable only from the Superintendent of Documents,  
Washington, D.C., lists all Government Publications on  
Subject. Price 15¢.
- Cir. No. 67 Measuring Haystacks. Price 5¢
- \*Cir. No. 72 Width of Wagon Tires Recommended for Loads of Varying  
Magnitudes on Earth and Gravel Roads. Price 5¢
- Cir. No. 81 Harvesting, Picking Thrashing and Storing Peanuts. Price 5¢

\*These publications are not available for distribution by the Department but may in most cases be purchased from the Superintendent of Documents, Washington, D.C., for the prices named, stamps not accepted.

Note:- A card index of all State Agricultural Experiment Station Publications is published by the Office of Experiment Stations, State Relations Service, Department of Agriculture, and sold for a nominal sum. Cards for new bulletins issued yearly. There are about 300 bulletins indexed under Rural Engineering, including 1915.

List of Publications relating to the subjects of Roads, Irrigation and Drainage may be had upon application to the Bureau of Public Roads, Department of Agriculture, Washington, D. C.



1. The first part of the document is a list of names of persons who have been identified as having been in contact with the subject of this investigation. The names are listed in alphabetical order and are as follows:

2. The second part of the document is a list of names of persons who have been identified as having been in contact with the subject of this investigation. The names are listed in alphabetical order and are as follows:

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10. The tenth part of the document is a list of names of persons who have been identified as having been in contact with the subject of this investigation. The names are listed in alphabetical order and are as follows:



U. S. DEPARTMENT OF AGRICULTURE.  
BUREAU OF PUBLIC ROADS.  
DIVISION OF RURAL ENGINEERING.

Void

Information Series-- No. 19

April, 1919

CEMENT OR CONCRETE PRODUCTS MACHINERY MANUFACTURERS  
MAGAZINES AND BOOKS ON SUBJECT? ETC..

BOOKS ON MANUFACTURE OF CEMENT AND CONCRETE PRODUCTS: (Partial list).

Cement concrete and Bricks by A. B. Searle, D. Van Nostrand Company, 25 Park Place  
New York.

Concrete Stone Manufacture, Book Department, Concrete, 310 New Telegraph Build-  
ing, Detroit, Mich.

Cement Pipe and Tile by E. S. Hanson, The Cement Era Publishing Co., Chicago, Ill.

Cement Tile, Concrete Publishing Company, Detroit, Mich.

Concrete Building Blocks by S. B. Newberry, Association of American Portland  
Cement Manufacturers, Philadelphia, Pa.

Practical Concrete Block Manufacture, 1919, by C. Palliser, Industrial Book Company  
New York.

Concrete Block Manufacture, 1906, by H. H. Rice, John Wiley and Sons, Inc., New York

The Manufacture of Concrete Blocks and Their Use in Building Construction by

H. H. Rice and others, 1906, Engineering News, New York.

Cement Drain Tile, 3rd edition 1912, Universal Portland Cement Co. New York.

MONTHLY PUBLICATIONS DEALING WITH CEMENT AND CONCRETE PRODUCTS:

Cement and Engineering News published by Wm. Seafert, 672 Transportation Building  
Chicago, Ill.

Cement World published by The International Trade Press, Inc., Monadnock Block  
Chicago, Ill.

Concrete published by the Concrete-Cement Age Publishing Co. Detroit, Mich.

The Cement Era published by The Cement Era Publishing Co., Chicago.

The Concrete Age Published by Concrete Age Publishing Co, Atlanta, Georgia.

MANUFACTURERS OF CEMENT CONCRETE PRODUCTS MACHINERY: (Partial List)

NOTE: The numbers following the names below indicate that the companies manufac-  
ture the machines for manufacturing the products carrying similar numbers in the  
marginal headings.

CAR: (1)

The Chase Foundry & Mfg. Co. Columbus, Ohio.

Globe Machinery & Supply Co., Des Moines, Iowa.

BRICK (2)

The Peerless Brick Machine Co., 1238 Central Ave., Minneapolis, Minn  
La Grange Specialty Co; La Grange, Ind. (The Little Giant Brick Machine)

Merrill Moore, Creston, Iowa. (Moulds).

C. S. Wert, Kendallville, Ind. (5).

Helm Brick Machine Co. 342 Mitchell St., Cadillac, Mich. (5)

Casper S. Davidian, Lawrence, Mass. (5)



U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

April, 1919

Information Series—No. 19

CEMENT OR CONCRETE PRODUCTS MANUFACTURING  
MAGAZINES AND BOOKS ON SUBJECTS ETC.

BOOKS ON MANUFACTURE OF CEMENT AND CONCRETE PRODUCTS (Partial List)

- Cement concrete and Bricks by A. B. Seale, D. Van Nostrand Company, 25 Park Place New York.
- Concrete Stone Manufacture, Book Department, Concrete, 510 New Telegraph Bldg. Chicago, Ill.
- Cement Pipe and Tile by E. S. Hanson, The Cement and Publishing Co., Chicago, Ill.
- Cement Tile, Concrete Publishing Company, Detroit, Mich.
- Concrete Building Blocks by S. B. Newberry, Association of American Portland Cement Manufacturers, Philadelphia, Pa.
- Practical Concrete Block Manufacture, 1919, by C. F. Palmer, Industrial Book Company New York.
- Concrete Block Manufacture, 1906, by H. H. Rice, John Wiley and Sons, Inc., New York.
- The Manufacture of Concrete Blocks and Their Use in Building Construction by H. H. Rice and others, 1908, Engineering News, New York.
- Cement Bricks, 2nd edition 1911, Universal Portland Cement Co., New York.
- MONTHLY PUBLICATIONS DEALING WITH CEMENT AND CONCRETE PRODUCTS:
- Cement and Engineering News published by The Engineers, 375 Transportation Building Chicago, Ill.
- Cement World published by The International Trade Press, Inc., Hammond Block Chicago, Ill.
- Concrete published by The Concrete-Cement Age Publishing Co., Detroit, Mich.
- The Cement Age published by The Cement Age Publishing Co., Chicago.
- The Concrete Age published by Concrete Age Publishing Co., Atlanta, Georgia.
- MANUFACTURERS OF CEMENT CONCRETE PRODUCTS MONTHLY (Partial List)
- NOTE: The numbers following the names below indicate that the companies manufacture the machines for manufacturing the products carrying similar numbers in the marginal headings.

BAR: (1)  
The Glass Bottle & Mfg. Co., Columbus, Ohio.  
Glass Machinery & Supply Co., Los Angeles, Iowa.

BRICK (2)  
The Federal Brick Machine Co., 1225 Central Ave., Minneapolis, Minn.  
In Strong Specialty Co.; In Strong, Ind. (The Little Giant Brick Machine)  
Lorill Moore, Co., (Ind.).  
C. S. Wolf, Knoxville, Ind. (5).  
Helm Brick Machine Co., 602 Mitchell St., Coalinga, Calif. (5).  
C. S. Wolf, Knoxville, Ind. (5).



Besser Manufacturing Co., Alpena, Michigan, (3) (4) (5)  
Eclipse Machine Mfg. Co., 400 Factory Place, Kendallville, Indiana. (3) (5) (6)

DRAIN TILE (3)

Raber and Lang Mfg. Co., 805 Mill St., Kendallville, Indiana. (4) (5)  
Cement Tile Machinery Co., 404 Rath St., Waterloo, Iowa. "Dope Book" free (5)  
Waterloo Cement Machinery Corporation, 125 Vinton St., Waterloo, Iowa. (4)  
Farmers' Cement Tile Machine Co., St. Johns, Michigan.  
Sioux City Engine and Machinery Co., Sioux City, Iowa. (4)  
W. E. Dunn Mfg. Co., Holland, Michigan. (4) (5)  
Quinn Wire and Iron Works, Boone, Iowa. (National Tile Machines)

See also under Brick (2)

SEWER PIPE. (4)

See under Brick (2) - Drain Tile (3)

BLOCK. (5)

Anchor Concrete Stone Co., Rock Rapids, Iowa. (8)  
The Ferguson Synstone Company, 809 - 17th St., Denver, Colorado.  
John H. Irely, West Liberty, Iowa. (Irely Molds)  
The Motes Co., 309 E. Franklin St., Jackson, Michigan.  
The Multiplex Concrete Machinery Co., Elmore, Ohio.  
U. S. Standard Mfg. Co., Ashland, Ohio.  
Ideal Concrete Machinery Co., 1300 Monmouth Ave., Cincinnati, Ohio.  
The Hobbs Concrete Machinery Co., 1445 West Grand Boulevard, Detroit, Michigan.  
Republic Iron Works, Tecumseh, Michigan.  
Kramer Automatic Tamper Co., Peoria, Illinois. (8)  
Zagelmeyer Cast Stone Block Machinery Co., 91 Crump Ave., Bay City, Michigan.  
Jackson Furnace and Foundry Co., 114 West Clark St., Jackson, Michigan. (8)  
Hydro-Stone Co., 269 Insurance Exchange, Chicago.  
The Baute Concrete Machinery Co., Benton Harbor, Michigan. (8)  
The Century Cement Machine Co., 60 Brown's Race, Rochester, New York.  
Greer Machinery Co., Delaware, Ohio. (The Hazelton Power Tamper and Cement Block Machine) (8)

See also under Brick (2) - Drain Tile (5)

FENCE POSTS. (6)

The Ohio Post Mold Co., 1358 Nicholas Bldg., Toledo, Ohio, U. S. A.  
Staple Post Mold Co., Westerville, Ohio.  
D. and A. Post Mold Co., Three Rivers, Michigan.

ROOF TILE. (7)

Water Concrete Machinery Co., Saks Bldg., Indianapolis, Indiana. ("Water Concrete Tile")  
L. Hansen and Co., 3617 East 23rd St., Kansas City, Missouri.

MACHINE TAMPERS. (8)

See under Block (5)

MISCELLANEOUS.

B. F. Gibler, Manston, Wisconsin. (Gibler Facing Sheet Machine) (Rock facing)



Bestest Manufacturing Co., Chicago, Michigan, (2) (4) (5)  
Keltos Machine Mfg. Co., 400 Broadway Place, Kalamazoo, Michigan, (2) (5) (6)

MAIN TILES (2)  
Robert and Sons Mfg. Co., 808 Main St., Kalamazoo, Michigan, (4) (5)  
Cement Tile Machinery Co., 400 Main St., Kalamazoo, Michigan, (2) (5)  
Western Cement Machinery Corporation, 125 North St., Kalamazoo, Michigan, (4)  
Western Cement Tile Machine Co., 211 Main St., Kalamazoo, Michigan, (4)  
Blum City Engine and Machinery Co., 211 Main St., Kalamazoo, Michigan, (4)  
W. J. Brown Mfg. Co., Holland, Michigan, (4) (5)  
Cotton Wire and Iron Works, Brown, Iowa, (Holland Tile Machine)

See also under Brick (2)

BRICK PIER. (4)  
See under Brick (2) - Train Tile (2)

BRICK. (5)  
Another Concrete Stone Co., Rock Rapids, Iowa, (5)  
The Ferguson Systems Company, 609 - 17th St., Denver, Colorado, (5)  
John H. Levy, West Liberty, Iowa, (Lark Mfg.)  
The Motor Co., 808 E. Franklin St., Jackson, Michigan, (5)  
The Michigan Concrete Machinery Co., Elmore, Ohio, (5)  
U. S. Standard Mfg. Co., Jackson, Ohio, (5)  
Ideal Concrete Machinery Co., 1200 Monument Ave., Cincinnati, Ohio, (5)  
The Hobbs Concrete Machinery Co., 1445 West Grand Boulevard, Detroit, Michigan, (5)  
Kupelian Iron Works, Tecumseh, Michigan, (5)  
Kupelian Automatic Engine Co., Tecumseh, Michigan, (5)  
Kupelian Cast Stone Brick Machinery Co., 21 Grand Ave., Bay City, Michigan, (5)  
Jackson Furnace and Foundry Co., 114 West Grand St., Jackson, Michigan, (5)  
Hydro-Stone Co., 303 Exchange Building, Chicago, (5)  
The West Concrete Machinery Co., Benton Harbor, Michigan, (5)  
The Century Concrete Machine Co., 60 Broadway Place, Rochester, New York, (5)  
Great Machinery Co., Delaware, Ohio, (The Jackson Power Engine and Concrete Block Machine) (5)

See also under Brick (2) - Train Tile (2)

BRICK POTS. (5)  
The Ohio Pot Mfg. Co., 1235 Michigan St., Toledo, Ohio, U. S. A., (5)  
Staple Pot Mfg. Co., Westerville, Ohio, (5)  
B. and A. Pot Mfg. Co., Three Rivers, Michigan, (5)

ROOF TILES. (7)  
Lafayette Concrete Machinery Co., Salem, Mass., Indianapolis, Indiana, (Lafayette Concrete Tile)  
L. Hanson and Co., 221 East 22nd St., Kansas City, Missouri, (5)

MACHINE TILES. (5)  
See under Brick (2)

INDUSTRIAL. (5)  
B. E. Gibson, Houston, Wisconsin, (Gibson Patent Sheet Machine) (Roof Tile)



U. S. DEPARTMENT OF AGRICULTURE  
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING  
DIVISION OF RURAL ENGINEERING

Void

Information Series - No. 20

September, 1917.

CORN PRODUCTS MANUFACTURE, GRAIN HANDLING, STORAGE, ETC.

PARTIAL LIST OF PUBLICATIONS ON CORN:

- "Corn - Growing, Judging, Breeding, Feeding, Marketing," by M. L. Bowman and B. W. Crosley. Published by the authors, Ames, Iowa, 1908. - Chap. 14, pp. 322-344, "The Commercial Products of Corn," - those derived from the kernel, the cob, and the plant itself. 479 pp. - figs. 172.
- "Maize - Its History, Cultivation, Handling, and Uses," (With special reference to South Africa.) A text book for farmers, students of agriculture, and teachers of nature study, by Jos. Burt-Davy. Longmans, Green and Co., London, New York, Bombay, Calcutta, 1914. 831 pp. - figs. 245 - Bibliography. Chap. 13, pp. 629-672, "The Milling, Mill Products, and Chemical Composition of Maize Grain."
- "Maize Cobs and Straw for manufacture of Illuminating Gas," - in The Garden Magazine, November, 1907.
- "Maize Husks as Paper Material," Transvaal Agricultural Journal, Vol. 14, Nos. 14 & 15, January and April, 1906, pp. 366-70 and 611-12, by Burt-Davy.
- "Descriptive Catalog of Useful Fibre Plants of the World," Report No. 9, Office of Fibre Investigations, U. S. Department of Agriculture, Washington, D. C. By J. R. Dodge.
- "Report on the Value of a New Corn Product", Maryland State Agricultural Experiment Station Bulletin No. 43.
- "Industrial Alcohol - Sources and manufacture," by H. W. Wiley. Farmers' Bulletin 268, U. S. Department of Agriculture, 1907, 45 pp. - figs. 10 - Stalks of Indian Corn and Sorghum."
- "Distillation and Rectification," by Brant - 214 pp. Still for making industrial alcohol from corn, etc., included.
- "The Story of Corn," by E. C. Brooks. Rand McNally & Co., 1916. Chap. XVIII - "Corn, The Natural Grain & The Most Common Food Product."
- "Drying Machinery and Practice," by Thos. B. Marlow. B. Lockwood & Sons, London, 1910. 326 pp. and 20 pp. in preface.

PUBLICATIONS AND ARTICLES ON MILLING, GRAIN HANDLING, GRAIN BINS, ETC.

- "American Cooperative Journal," Chicago, Ill.
- "The American Miller," Chicago, Ill.
- "The Grain Growers' Guide," Winnipeg, Manitoba.
- "American Society of Agricultural Engineers," Proceedings Vol. VII of the Dec. 1913, Chicago meeting, - "Methods and Benefits of Grading and Cleaning Grain." Report of Special Committee on Grain Cleaning Contest.
- "Engineering News." Articles on grain pressures in bins. March 10, 1904 - pp. 236 - 243 - Grain pressures in deep bins, By J. A. Jamison, C. E. (Elevator Engineer, Montreal, B. C., Can.) 6½ pages, fully illustrated.
- April 28, 1904 - p. 404 - "Hydraulic Diaphragms and Grain Pressure Tests," by H. A. Vantelet, Consulting Engineer. Letter of Criticism; also reply by J. A. Jamison.



U. S. DEPARTMENT OF AGRICULTURE  
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING  
DIVISION OF RURAL ENGINEERING

September, 1914

Information Series - No. 20

NEW PRODUCTS MANUFACTURED BY GRAIN HANDLING, STORAGE, ETC.

PARTIAL LIST OF PUBLICATIONS ON CORN:

- "Corn - Growing, Marketing, Feeding, etc." by M. J. Foxworth and R. W. Crossley. Published by the authors, Ames, Iowa, 1908. pp. 323-344. "The Commercial Products of Corn," - those derived from the kernel, the cob, and the plant itself. 478 pp. - 1 fig. 172.
- "Maize - Its History, Cultivation, Handling, and Uses." (With special reference to South Africa.) A text book for farmers, students of agriculture, and teachers of nature study, by John Burtt-Lundy. Longmans, Green and Co., London, New York, Bombay, Calcutta, 1914. 831 pp. - 1 fig. 348 - 17 illustrations.
- Chap. 13, pp. 622-672, "The Milling, Mill Products, and Chemical Composition of Maize Grain."
- "Maize Cobs and Straw for manufacture of Illuminating Gas," - in The Garden Magazine, November, 1907.
- "Maize Husks as Paper Material," Transvaal Agricultural Journal, Vol. 14, Nos. 14 & 15, January and April, 1908, pp. 366-70 and 611-12, by Burtt-Lundy.
- "Descriptive Catalog of Useful Fibre Plants of the World," Report No. 2, Office of Fibre Investigations, U. S. Department of Agriculture, Washington, D. C. By J. R. Dodge.
- "Report on the Value of a New Corn Product," Maryland State Agricultural Experiment Station Bulletin no. 47.
- "Industrial Alcohol - Sources and Manufacture," by H. W. Wiley, Farmer's Bulletin 268, U. S. Department of Agriculture, 1907. 48 pp. - 1 fig. 10 - 1 illustration.
- "Distillation and Rectification," by Hyman - 214 pp. Still for making industrial alcohol from corn, etc., included.
- "The Story of Corn," by E. G. Brooks. Rand McNally & Co., 1914. Chap. XVII.
- "Corn, The Natural Grain of the West," by E. G. Brooks. Rand McNally & Co., 1914. Chap. XVII.
- "Drying Machinery and Practice," by Theo. E. Marlow. E. Lockwood & Sons, London, 1910. 326 pp. and 30 pp. in practice.

PUBLICATIONS AND ARTICLES ON MILLING, GRAIN HANDLING, GRAIN BINS, ETC.

- "American Cooperative Journal," Chicago, Ill.
- "The American Miller," Chicago, Ill.
- "The Grain Grower's Guide," Winnipeg, Manitoba.
- "American Society of Agricultural Engineers," Proceedings Vol. VII of the 1913, Chicago meeting - "Methods and Benefits of Grading and Cleaning Grain," Report of Special Committee on Grain Cleaning Control.
- "Engineering News," articles on grain presses in deep bins, by J. A. Jamison, C. E. pp. 352 - 713 - Grain presses in deep bins, 67 pages, fully illustrated.
- (Elevator Engineer, Montreal, B. C. Can.) 67 pages, fully illustrated.
- April 25, 1904 - p. 404 - "Hydraulic Discharge and Grain Presses Tests," R. A. Vaselet, Consulting Engineer. Letter of Criticism, also reply by J. A. Jamison.



- July 14, 1904 - pp. 32-34, "Experiments on Grain Pressures in Deep Bins and the Strength of Wooden Bins," by Henry T. Bovey, Dean of Faculty of Applied Science, McGill Univ., Montreal, P.Q. 2 pages, illustrated.
- Dec. 15, 1904 - pp. 531-532, "Tests of Grain Pressure in Deep Bins at Buenos Aires, Argentine," by Eckhardt Lufft, M.E., Esslingen bei Stuttgart, Germany, 2 pages illustrated.
- "The Cement Era." Articles on Storage.
- May, 1917 - p. 45 - "The Value of Grain Storage Tanks on the Farm," by Ernest McCullough. Comparison between storage tanks and sacking, in favor of the former. Illustrated.
- April, 1917 - p. 61 - "Bins Easily Made." 2 illustrations. Hint for cheap and easy construction.
- Jan. 1917. - pp. 42-44 - "Design of Bins for Materials," by Ernest McCullough. Tables and diagrams. Concrete Construction.
- "The Design of Walls, Bins and Grain Elevators," by Milo S. Ketchum. New York, 1916 (2nd edition) 556 and 19 pages.

PARTIAL LIST OF CORN PRODUCTS MANUFACTURERS:

- Corn Products Manufacturing Co., Chicago, Ill.
- Corn Products Refining Co., New York, N. Y.
- American Hominy Co., Indianapolis, Ind.
- Seman's Edible Oil Co., Indianapolis, Ind.
- Van Camp Packing Co., Indianapolis, Ind. (Hominy)
- Masco Mills, Pine Bluffs, Arkansas.
- Hirschl and Bendheim, St. Louis, Mo. (Cob pipe industry)

PARTIAL LIST OF MANUFACTURERS OF CORN MILLING MACHINERY:

- Essmuelier Co., St. Louis Mo.
- Nordyke & Marmon Co., Indianapolis, Ind.
- Sprout Waldron & Co., Muncy, Penn.
- Ypsilanti Machine Works, Ypsilanti, Mich.
- Barnard & Leas Mfg. Co., Moline, Ill.
- The Wolf Co., Chambersburg, V.
- American Machinery Co., Port Huron, Mich.
- Cutler Co., North Wilbraham, Mass.

PARTIAL LIST OF MANUFACTURERS OF DRYERS:

- Hess Warming & Ventilating Co., Chicago, Ill.
- Strong Scott Manufacturing Co., Minneapolis, Minn.
- Fitz Water Wheel Co., Hanover, Penn.
- F. Robinson & Son, Ltd., Rockdale, England (Dryer & Conditioner).

PARTIAL LIST OF MANUFACTURERS OF STATIONARY AND PORTABLE GRAIN ELEVATORS AND WAGON DUMPS.

- Camp Bros. & Co., Washington, Ill.
- Cizek Bros. Mfg. Co., Clutier, Iowa.
- G. & D. Manufacturing Co., Streator, Ill.
- Hart Grain Weigher Co., Peoria, Ill.
- Fleming & Sons Mfg. Co., Huntsville, Mo.
- A. F. Meyer Mfg. Co., Morton, Ill.



1. The first of these is the "General List of Manufacturers of Machinery" which is a list of all the manufacturers of machinery in the United States. It is a list of the names of the manufacturers, their addresses, and the kinds of machinery they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of machinery they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of machinery they manufacture.

2. The second of these is the "List of Manufacturers of Iron and Steel" which is a list of all the manufacturers of iron and steel in the United States. It is a list of the names of the manufacturers, their addresses, and the kinds of iron and steel they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of iron and steel they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of iron and steel they manufacture.

3. The third of these is the "List of Manufacturers of Coal" which is a list of all the manufacturers of coal in the United States. It is a list of the names of the manufacturers, their addresses, and the kinds of coal they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of coal they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of coal they manufacture.

4. The fourth of these is the "List of Manufacturers of Lumber" which is a list of all the manufacturers of lumber in the United States. It is a list of the names of the manufacturers, their addresses, and the kinds of lumber they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of lumber they manufacture. It is a list of the names of the manufacturers, their addresses, and the kinds of lumber they manufacture.



King & Hamilton Co., Ottawa Ill.  
 Mafseilles Co., East Moline, Ill.  
 Meadows Mfg. Co., Pontiac, Ill.  
 Peoria Drill and Seed Co., Peoria, Ill.  
 Portable Elevator Mfg. Co., Bloomington, Ill.  
 Sandwich Mfg. Co., Sandwich, Ill.  
 H. V. Schroeder Mfg. Co., Minier, Ill.  
 Sterling Mfg. Co., Sterling, Ill.  
 Wengleman Mfg. Co., Galesburg, Ill.  
 Interlocking Fence Co., Morton, Ill.

PARTIAL LIST OF MANUFACTURERS OF ELEVATOR SUPPLIES:

Globe Machinery & Supply Co., Des Moines, Ia. (General Supplies)  
 J. L. Owens Co., Minneapolis, Minn. (Grain separators, etc.)  
 Twin City Separator Co., Minneapolis, Minn. (Adjustable Shape Elevator Cleaners, etc.)  
 B. S. Constant Mfg. Co., Bloomington, Ill. (Grain Cleaner, Corn Sheller, etc.)  
 American Supply & Machinery Co., Omaha, Neb. (General Elevator Supplies.)  
 The Challenge Mfg. Co., Morris, Ill. (Wagon Dumps, etc.)  
 J. J. Gerber, Minneapolis, Minn. (Spouting)  
 L. E. Taylor & Co. (General Elevator Supplies)  
 Northwestern Automatic Scale Co., Minneapolis, Minn.  
 The N. P. Bowsher Co., South Bend, Ind. (Feed Mills, etc.)  
 Union Iron Works, Decatur, Ill. (All elevator supplies, shellers, cleaners, etc.)  
 Richardson Scale Co., Chicago, Ill. (Registering scales, etc.)  
 Richardson Grain Separator Co., Minneapolis, Minn. (All elevator supplies)  
 W. H. Emerson & Son, Detroit, Mich. (Tester and Sorter)  
 Invincible Grain Cleaner Co., Silver Creek, N. Y. (Corn and small grain cleaner.)

PARTIAL LIST OF MANUFACTURERS OF GRAIN STORAGE BINS, TANKS, STORAGE BUILDINGS, ETC.

Butler Mfg. Co., Kansas City, Mo. and Minneapolis, Minn. (Metal grain bins)  
 The Diskelman Mfg. Co., Forest, Ohio. (All metal grain bins.)  
 Gilbert Manufacturing Co., Aberdeen, S. D. (Corrugated metal grain bins)  
 Harry Brothers Company of Louisiana, New Orleans, La. (Metal grain bins, etc.)  
 The Metal Shingle & Siding Co., Ltd., Winnipeg, Manitoba. (Ready made buildings for grain storage, etc.)  
 Union Iron Products Co., East Chicago, Ill. (Corrugated galvanized steel grain bins.)  
 Duluth Corrugating and Roofing Co., Duluth, Minn. (Corrugated galvanized steel grain bins)  
 Northfield Iron Co., Northfield, Minn. (Sectional metal combination bin and crib)  
 The Sioux Falls Metal Culvert Co., Sioux Falls, S. D. (Galvanized sectional metal grain bins)  
 Steel Fabricating Co., Chicago Heights, Ill. (Steel grain house)  
 Columbian Steel Tank Co., Kansas City, Mo. (Metal grain bins)  
 Tung-Lok Silo & Tank Co., Kansas City, Mo. (Wood grain bins, ready cut)



(Sole Agent) (Sole Agent)  
 (Sole Agent) (Sole Agent)  
 (Sole Agent) (Sole Agent)



Southern Pine Association, New Orleans, La. (Furnish working plans of grain bins, etc.)

Adel Clay Products Co., Adel, Iowa. (Corn cribs, grain storage houses, silos, etc. of hollow block)

Minneapolis Steel & Machinery Co., Minneapolis, Minn. (Steel grain storage tanks)

North Dakota Metal Culvert Co., Fargo, N. D. (Galvanized steel portable sectional grain bins)

#### PARTIAL LIST OF ELEVATOR BUILDERS.

The Three Americas Co., Chicago, Ill. (Grain elevators of all sizes and types)

Burrell Engineering & Construction Co., Chicago, Ill. (Grain elevators of concrete and wood.)

Claus Construction Co., Sibley, Iowa. (Builders of Elevators)

D. F. Hoag & Co., Minneapolis, Minn. (Engineers and constructors of grain elevators)

C. H. Benson, Minneapolis, Minn. (County elevator, warehouse, and mill construction.)

T. E. Ibbertson, Minneapolis, Minn. (Contracts and build grain elevators of wood, brick and concrete.)

Younglove Construction Co., Sioux City, Iowa. (Grain elevators of wood or fireproof construction)

Reliance Construction Co., Indianapolis, Ind. (Engineers and contractors for grain elevators.)

Newell Construction Co., Cedar Rapids, Iowa. (Contractors, designers and builders of grain elevators.)

Hiscock Construction Co., Minneapolis, Minn. (Engineers and contractors of grain elevators.)



and their fine association, New Orleans, La. (Special working plans of  
this firm, etc.)  
The First National Co., St. Louis, Mo. (Corn of the, grain storage houses,  
etc., etc. of hollow block)  
The National Steel & Machinery Co., Minneapolis, Minn. (Steel grain storage  
houses)  
The National Steel Building Co., Fargo, N. D. (Galvanized steel building  
material grain bins)

#### LIST OF FURNISHERS

The First National Co., Chicago, Ill. (Grain elevators of all sizes and  
types)  
The National Steel Building Co., Chicago, Ill. (Grain elevators  
of concrete and wood)  
The National Steel Building Co., St. Louis, Mo. (Grain elevators of grain  
storage and concrete)  
The National Steel Building Co., Minneapolis, Minn. (Grain elevators, and mill  
construction)  
The National Steel Building Co., Minneapolis, Minn. (Grain elevators and mill grain elevators  
of wood, steel and concrete)  
The National Steel Building Co., Sioux City, Iowa. (Grain elevators of wood or  
steel of construction)  
The National Steel Building Co., Indianapolis, Ind. (Engineers and contractors  
for grain elevators)  
The National Steel Building Co., Cedar Rapids, Iowa. (Contractors, designers and  
builders of grain elevators)  
The National Steel Building Co., Minneapolis, Minn. (Engineers and contractors  
of grain elevators)



U. S. DEPARTMENT OF AGRICULTURE  
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING  
DIVISION OF RURAL ENGINEERING

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Information Series - No. 21.

January, 1918.

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Housing.  
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PARTIAL LIST OF HOUSING ASSOCIATIONS.

Massachusetts Civic League, Housing Committee, Boston, Mass.  
National Housing Association, New York City.  
Charity Organization Society, Tenement House Committee, New York City.  
Brooklyn Bureau of Charities, Tenement House Committee, Brooklyn, New York.  
Ward Business Mens' Improvement Club, Philadelphia, Pa.  
Pennsylvania Housing and Town Planning Association, Philadelphia, Pa.  
New Jersey Housing Association.  
Indiana Housing Association.  
City Planning Institute.  
National Real Estate Association, Housing Committee.  
Philadelphia Housing Association, Philadelphia, Pa.

PARTIAL LIST OF HOUSING COMPANIES.

City Suburban Homes Company, New York City.  
Improved Dwelling Company, Brooklyn, New York.  
Octavia Hill Association, Philadelphia, Pa.  
Woodlawn Company, Wilmington, Del.  
Sanitary Housing Company, Washington, D. C.  
Sanitary Improvement Company, Washington, D. C.  
The Model Homes Company, Cincinnati, Ohio.

PUBLICATIONS.

"The National Housing Association (New York City) issues many pamphlets, booklets, and other publications pertaining to all phases of housing, in many of which the subject of sanitary conditions is fully gone into. These are to be had at very nominal prices, and their study and distribution is to be encouraged". Taken from the Journal of the American Institute of Architects, Sept., 1917, page 471.

What Other Cities Do not Know, published by the National Housing Association, New York City, 1915 - "Describes existing conditions in cities throughout the country as to vaults, privies, sewers, and general sanitation, with the progress in legislation law enforcement and improved dwellings, with a list of limited dividend companies in the United States and Canada which are seeking to improve wage earners' dwellings in villages, together with a list of official commissions or departments and of voluntary housing associations or committees."



U. S. DEPARTMENT OF AGRICULTURE  
OFFICE OF PUBLIC ROADS AND RAIL ENGINEERING  
DIVISION OF RURAL ENGINEERING

January, 1918.

Information Service - No. 11.

Housing

RECENT LIST OF HOUSING ASSOCIATIONS

Massachusetts State League, Housing Committee, Boston, Mass.  
National Housing Association, New York City.  
County of Essex Housing Society, Essex County Housing Committee, New York City.  
Essex County Housing Society, Essex County Housing Committee, New York City.  
Fair Housing League, Improvement Club, Philadelphia, Pa.  
Housing League, Housing and Town Planning Association, Philadelphia, Pa.  
New Jersey Housing Association.  
Indiana Housing Association.  
City Planning Institute.  
National Real Estate Association, Housing Committee, Philadelphia, Pa.  
Philadelphia Housing Association, Philadelphia, Pa.

RECENT LIST OF HOUSING OFFICERS

City Engineer, New York City.  
Improved Housing Company, Brooklyn, New York.  
Columbia Hill Association, Philadelphia, Pa.  
Hoodless Company, Wilmington, Del.  
Housing Improvement Company, Washington, D. C.  
Sanitary Improvement Company, Washington, D. C.  
The Model Home Company, Cincinnati, Ohio.

PUBLICATIONS

"The National Housing Association (New York City) issues many pamphlets, books, lists, and other publications pertaining to all phases of housing. In many of which the subject of sanitary conditions is fully given space. These are to be had at very nominal prices, and their study and distribution is to be encouraged. Taken from the Journal of the American Institute of Architects, Sept., 1917, page 471.  
These other cities do not show, published by the National Housing Association, New York City, 1915 - "Describes existing conditions in cities throughout the country as to rents, prices, streets, and general sanitation, with the power in legislation law enforcement and improved dwellings, with a list of limited dividend companies in the United States and Canada which are seeking to improve wage earners' dwellings in villages, together with a list of official examinations or departments and of voluntary housing associations or committees."



U. S. Bureau of Mines, Washington, D. C., Bulletin No. 87, Homes for Mining Towns. By J. M. White, 1914, 64 pages. Contains a treatise on the subject of the small house in groups and as small towns. Includes a discussion of the town site and enlargement of town with streets and alleys, types of houses, windows, doors, lighting, ventilation, screening, heating, interior and exterior finish, construction, the yard and its appurtenances, sources of water supply, disposal of wastes, sewer systems, substitution for sewers, and other subjects of vital interest as affecting the public health. Illustrated with map of model mining town, plans, elevations, and perspectives of houses, details of construction, and other data. Price 15 cents.

Russel Sage Foundation, New York City. Reports on Springfield, Ill., Topeka, Kansas, and Ithaca, N. Y., dealing with public health and with housing, have been published.

The Houses of Providence, By John Ihlder and others, 1916.

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U. S. Bureau of Mines, Washington, D. C., Bulletin No. 87, House for Mining  
Towns. By J. L. Tamm, 1915. 66 pages. Contains a treatise on the subject  
the small towns in America and as well towns. Includes a discussion of the  
town site and arrangement of town with streets and alleys, types of houses,  
church, school, light, ventilation, heating, interior and  
exterior lighting, construction, the yard and its surroundings, sources of  
water supply, disposal of waste, sewer system, sanitation for safety,  
and other subjects of vital interest in planning the public health. 11-  
illustrated with map of model mining town, plans, elevations, and perspective  
of houses, details of construction, and street data. Price 15 cents.  
New York City. Reports on Springfield, Ill., Tokyo,  
Japan, and Ithaca, N. Y., dealing with public health and urban planning. New  
York published.  
The Bureau of Hygiene, by John Fisher and others, 1915.



U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
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Special

Information Series - No. 22. (revised)

January, 1918.

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WOOL, WOOL WASHING, SCOURING, ETC.

DIRECTORIES

- Official American Textile Directory (1917). Compiled by Textile World Journal, Bragdon, Lord & Nagle Co., 461-479 - 8th Ave., Cor. 34th St., New York City; or 1723 Lytton Bldg., Chicago, Illinois.
- Davison's Textile Blue Book (July, 1917), with a Full Classified Directory of Cotton and Woolen Manufacturers and a Textile Supply Directory. Published by Davison Publishing Co., 107 Broadway, New York City. - Office Edition.
- The Wool Yearbook (1917). Published by "The Textile Mercury", Carr St., Manchester, England.

ASSOCIATION.

- National Wool Growers Association.

PERIODICALS.

- National Wool Growers, Salt Lake City, Utah.
- The Wool Record.
- Shepherds' Journal, 1700 Tower Bldg., Chicago, Illinois.
- The American Wool and Cotton Reporter.
- Wool Markets and Sheep Periodical (Weekly), Chicago, Illinois.

BOOKS, BULLETINS, ETC.

- The Wool Grower and the Wool Trade. By F. R. Marshall and L. L. Heller, U. S. Department of Agriculture Bulletin No. 206, 1915, 32 pages, 1 fig.
- Live Stock, 1916, and Miscellaneous Data. U. S. Department of Agriculture Yearbook Separate 721, 1916, 47 pages.
- Differences of Weight Between Raw and Clean Wools. By Walter S. Lewis, U. S. Department of Commerce, Bureau of Standards Technologic Paper No. 57, 1915, 5 pages, including tables. (Library of Congress No. T1.U6 No. 57 - TS 1547.14)
- Souring of Wool in Belgium, Great Britain, and Germany. U. S. Department of Commerce. U. S. Consular Reports (monthly), 1918.
- Railway Charges for the Transportation of Wool. U. S. Department of Commerce, Bureau of Statistics. Miscellaneous Bulletin No. 10.
- Shrinkage of Wool. By C. F. Curtis. Iowa State Agricultural College, Bulletin No. 21 (1893, pages 775-777.)
- Production and Marketing of Wool. Michigan Agricultural Experiment Station Bulletin No. 178.
- Wool Investigations. Wyoming Agricultural Experiment Station. 19th Annual Report, 1908-09, page 13. Also 20th Annual Report 1909-10.
- Wool and Its Manufacture. By T. Reg. Arkell. Dominion Department of Agriculture, Pamphlet No. 3, April, 1914.
- Preparing Wool for Market. By T. Reg. Arkell, Dominion Department of Agriculture, Pamphlet No. 2, April, 1914.
- From Wool to Cloth. By Jas. T. Shaw, Secretary American Woolen Co., Providence, Rhode Island. Printed by Livermore and Knight Co., 1904, 46 pages. (Library or Congress No. TS 1630.S5).







- The Manufacturing Processes of Wool and Worcested. By John Lister of Pendleton... Manchester, (England) A. Heywood and Son, 1911, 205 pages, illus. (Library of Congress No. TS 1625.L5).
- Wool from the Raw Material to the Finished Product. By J. A. Hunter. Sir I. Pitman and Sons, Ltd., London, New York, Etc., 1912, 118 pages, illus., diags., (Pitman's Common Commodities of Commerce) (Library of Congress No. HD 9890.5.H8).
- Woolen and Worcested Cloth Manufacture; being a practical treatise for the use of all persons employed in the manufacture of textile fabrics. By Robert Beaumont... With over 200 illustrations, 3rd edition rewritten, London. G. Bell & Sons, 1899, 471 pages 'Half title, Technological Handbooks, edited by H. T. Woods) (Library of Congress No. TS 1625.B37).
- Processes and Difficulties of Scouring and Dyeing. National Association of Wool Gatherers. Vol. 45, No. 2, pages 146-172, April, 1915.
- A Clip of Wool From Shearing Shed to Ship. By Alexander Sinclair, 26 Hunter St., Sydney, Australia.
- Romance of the Wool Trade. By Jas. Bonwick, London. Griffith, Farrar, Okeden, and Welsh, 1877.
- The American Shepherd's Handbook.

#### PUBLISHED ARTICLES.

- Scouring Wool at Home. By Hammond. Breeders' Gazette, March 30, 1916, page 723.
- Methods of Putting Up Wool For Market. By J. A. Hill, American Sheep Breeder, May, 1910.
- Cost of Wool Production; Analysis of Tariff Board Report. National Wool Grower, May, 1913.
- Putting up Wool For Market in Australia. National Wool Grower, May, 1913, page 36.
- Wool Sacks, Paper Lined. National Wool Grower, June, 1913.
- Wool to Cloth, American Sheep Breeder, June, 1912.

#### MANUFACTURERS OF WOOL WASHERS, AND PREPARING AND DRYING MACHINERY.

##### Saponification Method.

|                                      |                     |
|--------------------------------------|---------------------|
| Atkinson, Haserick and Co.,          | Boston, Mass.       |
| Buhlmann, A. W.                      | New York.           |
| Butterworth, H. W., and Sons Co.,    | Philadelphia.       |
| Hunt, Rodney, Machine Co.,           | Orange, Mass.       |
| Hunter, Jas. Machine Co.,            | No. Adams, Mass.    |
| Jefferson, Edward and Bro.,          | Philadelphia.       |
| Leigh and Butler,                    | Boston, Mass.       |
| Philadelphia Drying Machine Co.,     | Philadelphia.       |
| Sargent, C. G., and Sons Corp.,      | Graniteville, Mass. |
| Schwartz, L.H. A. and Co.,           | Boston, Mass.       |
| Speed and Stephenson,                | Boston, Mass.       |
| The Textile Finishing Machinery Co., | Providence.         |

##### Solvent Method.

|              |                                    |
|--------------|------------------------------------|
| Draw, E. H., | New York (also recovery apparatus) |
|--------------|------------------------------------|

#### MANUFACTURERS OF WOOL-SCOURING COMPOUNDS

|                         |                                 |
|-------------------------|---------------------------------|
| Arnold Hoffman and Co., | Providence.                     |
| Avery Chemical Co.,     | Boston.                         |
| Fick Mfg. Co.,          | Springfield, Mass.              |
| Fox, Chas. J.           | Philadelphia                    |
| Holbrook Mfg. Co.,      | Jersey City (Ammoniated Potash) |







Jaeck, Louis Co.,  
Rosentwish and Gormer,  
Seydel Mfg. Co.,  
Tanner, Chas. S. Co.,  
Warren Soap Mfg. Co.,  
Wolf, Jacques & Co.,

New York,  
Boston.  
Jersey City.  
Providence.  
Boston.  
Passaic, N. J.

#### WOOL SCOURERS.

Grubnan, Carl, and Son,  
Philadelphia Wool Scouring and Carbonizing Co.,  
Evenson and Levering,

Philadelphia.  
Philadelphia.  
Camden, N. J.

#### MISCELLANEOUS.

##### Average Weights of Fleeces.

|               |                      |
|---------------|----------------------|
| United States | 7.3 lbs. per fleece. |
| Australia     | 7.25 " " "           |
| South America | 7.5 " " "            |
| Africa        | 6.5 " " "            |

##### Shrinkage of Wools (National Wool Grower, May, 1913).

|                       |                |
|-----------------------|----------------|
| Ohio                  | 60.00 per cent |
| Western United States | 62.00 " "      |
| Average United States | 60.40 " "      |
| England               | 25.10 " "      |
| Australia             | 48.54 " "      |
| South America         | 51.04 " "      |
| Africa                | 58.40          |

#### WOOL WASHING. (From the Wool Year-book, 1917 page 93.)

"The impurities in wool may be classed:- (1) Yolk or wool fat. (2) Suint or sheep's perspiration. (3) Dirt. Yolk is insoluble in water, but soluble in volatile solvents; e.g., benzene, ether, carbon bisulphide. Yolk does not (like ordinary fats) form soluble soaps with alkalis, but it emulsifies, and on this property are based the usual scouring processes. Suint consists of potash salts of certain acids that are soluble in water. Hence steeping removes the suint. There are three general methods of treating the wool; (a) By dissolving the yolk with a volatile solvent, and washing with warm water to remove the suint. (b) By scouring with alkaline agents. (c) By steeping to remove the suint, and scouring afterwards to remove the yolk.

"The advantages of the first method are that (1) a solution can be selected that does not hurt the fibre; (2) both solvent and yolk can be recovered; (3) the process is made automatic. Unfortunately these solvents are very inflammable, involving risk of fire, and noxious fumes are given off. The Solvent Belge, at Verviers, in Belgium, and the Arlington Mills, Lawrence, Mass., U.S.A., use the Maertens process, whereby the raw wool is treated in closed digesters by crude naphtha."

Following the above article are articles (pages 93-102) on Wool-Washing Machines; Scouring Losses; Steeping or Desuinting Wash Bowls; Constitution of Wash Bowls; Automatic Feeder for Scouring Bowls. and Wool Scouring by electricity.

Also (page 381) Wool-Scouring Liquor; Piece-scouring Liquor; and Mixed Liquors.

Also (pages 420-422) New Process for recovery of Grease and Potash From Scour Liquors.







U. S. DEPARTMENT OF AGRICULTURE  
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING  
DIVISION OF RURAL ENGINEERING

Void

Information Series - No. 23. (Revised)

April, 1918.

STORAGE STRUCTURES - FRUIT AND VEGETABLE.

FRUIT STORAGE PUBLICATIONS.

DEPARTMENT OF AGRICULTURE PUBLICATIONS. (Obtainable from U. S. Department of Agriculture, except starred publications).

- \*Farmers' Bulletin 291, "Evaporation of Apples", by H. P. Gould, 1907, 38 pp., 16 figs. Bulletin contains plans of several types of kiln evaporators for drying fruit. Price 5 cents.
- Farmers' Bulletin 696, "Handling and Shipping Citrus Fruits in the Gulf States", by H. J. Ramsey, 1915, 28 pp., 10 figs. Packing-house methods described and equipment shown in the bulletin.
- Farmers' Bulletin 352, "Management of Common Storage Houses for Apples in the Pacific Northwest", by H. J. Ramsey and S. J. Dennis, 1917, 23 pp., 4 figs. Bulletin deals with the fundamentals of construction and the efficient management of common storage houses for apples under conditions prevailing in Washington, Oregon, Idaho, and Montana.
- Farmers' Bulletin 879, "Home Storage of Vegetables", by James H. Beattie, 1917, 22 pp., 20 figs. Several types of storage cellars shown and discussed. "Conditions suitable for the keeping of potatoes answer fairly well for apples".
- Farmers' Bulletin 903, "Commercial Evaporation and Drying of Fruit", by James Beattie and H. P. Gould, 1917, 60 pages, 22 figs. Bulletin contains plans and description of buildings and equipment for drying fruit.

STATE PUBLICATIONS. (Apply to the various Stations).

- North Carolina Agricultural Experiment Station, Raleigh, North Carolina, Bulletin 228, "Apple Storage Houses, Air-Cooled", 1914. This bulletin points out the essential features in the construction of air-cooled storage houses and illustrates both in plan and section, typical storage houses.
- Colorado State Agricultural College, Ft. Collins, Colorado. Extension Bulletin Ser. 1, No. 121, "Farm Storage of Apples and Potatoes", 1917. A four-car-capacity storage cellar described with illustrations, materials of construction, etc. Apple and potato storage methods discussed.

VEGETABLE STORAGE PUBLICATIONS.

DEPARTMENT OF AGRICULTURE PUBLICATIONS. (Obtainable from U. S. Department of Agriculture, except starred publications).

- Farmers' Bulletin 548, "Storing and Marketing Sweet Potatoes", by H. C. Thompson, 1913 (reprinted in 1917), 15 pp. 9 figs. Bulletin shows details of construction and materials required for a sweet potato storage house 20 ft. x 40 ft. capacity 2,500 to 3,000 bushels.







\*Farmers' Bulletin 549, "Experiment Station Work LXXVI", 1913. Bulletin contains article on page 9 "Storage of Potatoes" compiled from Colorado Station Bulletin 175, and North Dakota Station Bulletin 101. Plans for potato storage warehouse 24 ft. x 64 ft., with a capacity of 10,000 bushels. Price 5 cents.

Farmers' Bulletin 847, "Potato Storage and Storage Houses", by William Stuart 1917, 27 pp., 20 figs. Bulletin discusses in detail several types of potato storage houses.

Farmers' Bulletin 879, "Home Storage of Vegetables", by James H. Beattie, 1917, 22 pages, 20 figs. Bulletin shows and describes several types of vegetable cellars, caves, mounds, etc.

STATE AND OTHER PUBLICATIONS. (Apply to the various Stations).

Georgia Experiment Station, Athens, Georgia.

Bulletin 107, "Sweet potato Storage House", 1914. Description of a sweet potato storage house 26 ft. x 50 ft. having a capacity of 40 to 50 acres of crop. Detailed plans of the house are given including bill of materials.

Bulletin 139, Extension Division, Vol. VI, No. 11, "Growing Sweet Potatoes in Georgia", 1917. Description of sweet potato storage house 20 ft. x 40 ft. with a capacity of 2,500 to 3,000 bushels. Plans are given with a bill of materials.

North Dakota Agricultural Experiment Station, Agricultural College, N. D.

Bulletin 101, "Potato Warehouse Plans", 1912. Details of construction are given (a) of an inexpensive potato cellar of the roofed-pit type; (b) a warehouse of the basement type, and (c) a warehouse providing storage in both basement and superstructure.

Bulletin 11, Agricultural Extension Department, "Potato Storage in North Dakota," 1917. Several types of pit cellars are shown and described. Lumber specifications are given.

Arkansas Agricultural Experiment Station, Fayetteville, Ark.

Extension Division Circular 49, "Sweet Potato Storage", 1917. Bulletin describes a storage house 20 ft. x 30 ft., giving floor plan, ventilating system, methods of operation, etc.

Virginia Agricultural Experiment Station, Blacksburg, Va.

Bulletin 58, "A new plan for the Construction of a Storage Cellar", 1895.

Bulletin contains discussion on the requirements of storage cellars, with plan, elevation, and sectional drawings of the house discussed.

Texas Agricultural Experiment Station, College Station, Tex.

Extension Service Bulletin No. B-27, "Growing and Storing Sweet Potatoes".

Bulletin deals with a 650 bushel potato curing house. Details of construction, bill of materials, and cost data are given.

Colorado Agricultural Experiment Station, Ft. Collins, Colo.

Bulletin 232, "Housing and Storing Vegetables for Home Use". Pit-type storage shown and discussed.

Utah Agricultural Experiment Station, Logan, Utah.

Circular 26, "Storing Vegetables for Winter". Discussion of the principles of storage of vegetables illustrated by several types of storage structures.

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\*Obtainable only from the Superintendent of Documents Government Printing Office, Washington D. C., at prices noted. Stamps not accepted.







Manitoba Department of Agriculture, Winnipeg, Canada.

Extension Bulletin No. 17, "Vegetable Storage", 1917. Four types of root cellars illustrated and discussed. Drawings show the construction of the cellar.

British Columbia Department of Land, Forest Service, Victoria, B. C.

Farm Building Series Bulletin No. 9, "Silos and Root Cellars". pp. 28-34. Drawings and bill of materials for root cellar 12 ft. x 32 ft., having bin capacity for about 3,000 bushels.

#### PARTIAL LIST OF PUBLISHED ARTICLES.

Country Gentleman, Philadelphia, Pa.

Sept. 22, 1917. page 20. The Home Garden.

Article shows floor plan of a single storage cellar, and takes up structural features, etc.

Oct. 9, 1915. page 4. Sweet potatoes in Storage.

Article shows an ideal storage house of the Commercial Type, with top and side ventilation, also a house with no ventilation where "more than sixty per cent of the crop rots every year".

Feb. 19, 1916. page 409. A Potato Storage House.

A potato house 40 ft. x 60 ft. two-story bank type. A bill of materials is given with cost and labor data for the erection of the house.

Oct. 7, 1916. page 22. Everyman's Garden.

Illustration of an outside cellar or vegetable storage house walled up with stone or cement.

Nov. 25, 1916. page 29. Better Bins for Vegetables.

Photographs and discussion of a series of bins for the storage of vegetables.

Ohio Farmer, Cleveland, Ohio.

Oct. 12, 1917. pages 10-11. Farm Storage of Vegetables.

Detailed discussion of the subject with illustrations of the method of storing vegetables in mounds. Construction and ventilation of mound shown.

Heards' Dairyman, Ft. Atkinson, Wisc.

Sept. 14, 1917. pages 212-213. Vegetable or Root Storage Cellars, Storing Root Crops on the Farm.

Details of construction of two concrete root cellars 30 ft. x 76 ft., and 9 ft. x 14 ft. respectively; also a root cellar used in conjunction with a barn basement, a hillside cellar, and a mound type cellar shown and discussed.







DRAWINGS.

U. S. DEPARTMENT OF AGRICULTURE, OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING,  
DIVISION OF RURAL ENGINEERING.

Serial Nos.

|          |                      |          |              |
|----------|----------------------|----------|--------------|
| 881-B    | Sweet Potato House,  | Capacity | 500 bushels. |
| 894-95-B | "                    | "        | 2,500 "      |
| 875-A    | "                    | "        | 5,200 "      |
| 873-74-A | "                    | "        | 15,500 "     |
| 880-D    | Root Storage Cellar, | "        | 500 "        |
| 883-C    | "                    | "        | 1,000 "      |
| 892-A    | "                    | "        | 6,000 "      |
| 893-A    | "                    | "        | 5,600 "      |

Note:- These drawings with bills of materials are available, free of charge, upon request.

STATE COLLEGES.

Mississippi Agricultural and Mechanical College, Agricultural Extension Department, Agricultural College, Mississippi. Plan No. 182, "Sweet Potato House, for Kiln drying Sweet Potatoes". Size 20 ft. x 40 ft., capacity 2,500 to 3,000 bushels.

Iowa State College, Agricultural Extension Department, Ames, Iowa, Plan No. D-101, "Potato and Apple Storage House", price 5 cents. Size 12 ft. x 20 ft. x 12 ft. high. Concrete walls and floor tile.

Note:- The Bureau of Markets, U. S. Department of Agriculture, is now prepared to make definite recommendations as to grading and packing certain fruit and vegetable crops, fruit packing house plans and equipment, and general handling methods. Special attention has been given to apples, peaches, potatoes, Texas Bermuda onions, cantaloupes, and tomatoes, and a study of the various operations of harvesting, grading, packing, inspecting, and shipping has been started on other truck crops. (Quoted from the Weekly News Letter, Jan. 9, 1918, page 7.)

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U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
WASHINGTON, D. C.

Void

Information Series - No. 24.

Revised July, 1920.

POULTRY

DEPARTMENT OF AGRICULTURE PUBLICATIONS.

FARMERS' BULLETINS:

- \*No. 41, Fowls; Care and Feeding.
- \*No. 51, Standard Varieties of Chickens.
- \*No. 64, Ducks and Geese; Standard Broods and Management.
- \*No. 128, Eggs and Their Uses as Food.
- \*No. 141, Poultry Raising on the Farm. ✓
- \*No. 177, Squab Raising.
- \*No. 182, Poultry as Food.
- \*No. 200, Turkeys; Standard Varieties and Management.
- \*No. 234, The Guinea Fowl and its use as a Food.
- \*No. 236, Incubation and Incubators.
- \*No. 287, Poultry Management ✓
- No. 355, A Successful Poultry and Dairy Farm. ✓
- No. 357, Methods of Poultry Management at the Maine Agricultural  
Experiment Station.
- No. 390, Pheasant Raising in the United States.
- \*No. 445, Marketing Eggs Through the Creamery.
- \*No. 452, Capons and Caponizing.
- \*No. 528, Hints to Poultry Raisers.
- No. 530, Important Poultry Diseases.
- \*No. 562, Organization of Boys' and Girls' Poultry Clubs.
- No. 574, Poultry House Construction.
- No. 585, Natural and Artificial Incubation of Hens' Eggs.
- \*No. 594, Shipping Eggs by Parcel Post.
- No. 624, Natural and Artificial Brooding of Chickens.
- No. 656, Community Egg Circle.
- No. 682, Simple Trap Nest for Poultry.
- No. 684, Squab Raising.
- No. 697, Duck Raising. ✓
- No. 791, Turkey Raising.
- No. 801, Mites and Lice on Poultry.
- No. 806, Standard Varieties of Chickens; I. The American Class.
- No. 830, Marketing Eggs by Parcel Post.
- No. 849, Capons and Caponizing.
- No. 858, The Guinea Fowl.

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\* These bulletins may be obtained only from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices indicated. (Stamps not accepted).



Revised July, 1920.

Information Series - No. 20

BULLETIN

DEPARTMENT OF AGRICULTURE PUBLICATIONS

FARMERS' BULLETINS

|         |                                |
|---------|--------------------------------|
| No. 1   | How to Grow and Feed           |
| No. 2   | Standard Varieties of Chickens |
| No. 3   | How to Buy and Sell Poultry    |
| No. 4   | How to Buy and Sell Eggs       |
| No. 5   | How to Buy and Sell Poultry    |
| No. 6   | How to Buy and Sell Eggs       |
| No. 7   | How to Buy and Sell Poultry    |
| No. 8   | How to Buy and Sell Eggs       |
| No. 9   | How to Buy and Sell Poultry    |
| No. 10  | How to Buy and Sell Eggs       |
| No. 11  | How to Buy and Sell Poultry    |
| No. 12  | How to Buy and Sell Eggs       |
| No. 13  | How to Buy and Sell Poultry    |
| No. 14  | How to Buy and Sell Eggs       |
| No. 15  | How to Buy and Sell Poultry    |
| No. 16  | How to Buy and Sell Eggs       |
| No. 17  | How to Buy and Sell Poultry    |
| No. 18  | How to Buy and Sell Eggs       |
| No. 19  | How to Buy and Sell Poultry    |
| No. 20  | How to Buy and Sell Eggs       |
| No. 21  | How to Buy and Sell Poultry    |
| No. 22  | How to Buy and Sell Eggs       |
| No. 23  | How to Buy and Sell Poultry    |
| No. 24  | How to Buy and Sell Eggs       |
| No. 25  | How to Buy and Sell Poultry    |
| No. 26  | How to Buy and Sell Eggs       |
| No. 27  | How to Buy and Sell Poultry    |
| No. 28  | How to Buy and Sell Eggs       |
| No. 29  | How to Buy and Sell Poultry    |
| No. 30  | How to Buy and Sell Eggs       |
| No. 31  | How to Buy and Sell Poultry    |
| No. 32  | How to Buy and Sell Eggs       |
| No. 33  | How to Buy and Sell Poultry    |
| No. 34  | How to Buy and Sell Eggs       |
| No. 35  | How to Buy and Sell Poultry    |
| No. 36  | How to Buy and Sell Eggs       |
| No. 37  | How to Buy and Sell Poultry    |
| No. 38  | How to Buy and Sell Eggs       |
| No. 39  | How to Buy and Sell Poultry    |
| No. 40  | How to Buy and Sell Eggs       |
| No. 41  | How to Buy and Sell Poultry    |
| No. 42  | How to Buy and Sell Eggs       |
| No. 43  | How to Buy and Sell Poultry    |
| No. 44  | How to Buy and Sell Eggs       |
| No. 45  | How to Buy and Sell Poultry    |
| No. 46  | How to Buy and Sell Eggs       |
| No. 47  | How to Buy and Sell Poultry    |
| No. 48  | How to Buy and Sell Eggs       |
| No. 49  | How to Buy and Sell Poultry    |
| No. 50  | How to Buy and Sell Eggs       |
| No. 51  | How to Buy and Sell Poultry    |
| No. 52  | How to Buy and Sell Eggs       |
| No. 53  | How to Buy and Sell Poultry    |
| No. 54  | How to Buy and Sell Eggs       |
| No. 55  | How to Buy and Sell Poultry    |
| No. 56  | How to Buy and Sell Eggs       |
| No. 57  | How to Buy and Sell Poultry    |
| No. 58  | How to Buy and Sell Eggs       |
| No. 59  | How to Buy and Sell Poultry    |
| No. 60  | How to Buy and Sell Eggs       |
| No. 61  | How to Buy and Sell Poultry    |
| No. 62  | How to Buy and Sell Eggs       |
| No. 63  | How to Buy and Sell Poultry    |
| No. 64  | How to Buy and Sell Eggs       |
| No. 65  | How to Buy and Sell Poultry    |
| No. 66  | How to Buy and Sell Eggs       |
| No. 67  | How to Buy and Sell Poultry    |
| No. 68  | How to Buy and Sell Eggs       |
| No. 69  | How to Buy and Sell Poultry    |
| No. 70  | How to Buy and Sell Eggs       |
| No. 71  | How to Buy and Sell Poultry    |
| No. 72  | How to Buy and Sell Eggs       |
| No. 73  | How to Buy and Sell Poultry    |
| No. 74  | How to Buy and Sell Eggs       |
| No. 75  | How to Buy and Sell Poultry    |
| No. 76  | How to Buy and Sell Eggs       |
| No. 77  | How to Buy and Sell Poultry    |
| No. 78  | How to Buy and Sell Eggs       |
| No. 79  | How to Buy and Sell Poultry    |
| No. 80  | How to Buy and Sell Eggs       |
| No. 81  | How to Buy and Sell Poultry    |
| No. 82  | How to Buy and Sell Eggs       |
| No. 83  | How to Buy and Sell Poultry    |
| No. 84  | How to Buy and Sell Eggs       |
| No. 85  | How to Buy and Sell Poultry    |
| No. 86  | How to Buy and Sell Eggs       |
| No. 87  | How to Buy and Sell Poultry    |
| No. 88  | How to Buy and Sell Eggs       |
| No. 89  | How to Buy and Sell Poultry    |
| No. 90  | How to Buy and Sell Eggs       |
| No. 91  | How to Buy and Sell Poultry    |
| No. 92  | How to Buy and Sell Eggs       |
| No. 93  | How to Buy and Sell Poultry    |
| No. 94  | How to Buy and Sell Eggs       |
| No. 95  | How to Buy and Sell Poultry    |
| No. 96  | How to Buy and Sell Eggs       |
| No. 97  | How to Buy and Sell Poultry    |
| No. 98  | How to Buy and Sell Eggs       |
| No. 99  | How to Buy and Sell Poultry    |
| No. 100 | How to Buy and Sell Eggs       |



FARMERS' BULLETINS (continued)

- No. 889, Back-Yard Poultry Keeping.
- No. 898, Standard Varieties of Chickens: II. The Mediterranean and Continental classes.
- No. 957, Important Poultry Diseases.
- No. 1040, Illustrated Poultry Primer.
- No. 1052, Standard Varieties of Chickens, III. The Asiatic, English and French Classes.
- No. 1067, Feeding Hens for Egg Production.
- No. 1070, The Fowl Tick.

DEPARTMENT BULLETINS.

- No. 17. Refrigeration in Transit of Dressed Poultry. Price 10 cents.
- \*No. 21. Commercial Fattening of Poultry. Price 10 cents.
- No. 51. A Bacteriological and Chemical Study of Commercial Eggs in The Producing Districts of the Central West. Price 40 cents.
- No. 58. Five Important Wild Duck Foods. Price 5 cents.
- No. 205. Eleven Important Wild Duck Foods. Price 5 cents.
- No. 217. Mortality Among Water Fowls around Great Salt Lake, Utah. Price 5 cents.
- No. 224. A Study of the Preparation of Frozen and Dried Eggs in the Producing Section. Price 30 cents.
- \*No. 378. Fish Meal; Its Use as Poultry and Stock Food. Price 5 cents.
- No. 464. Poultry Lessons for Rural Schools. Price 10 cents.
- No. 465. Propagation of Wild Duck Foods. Price 10 cents.
- \*No. 467. Food Value and Uses of Poultry. Price 5 cents.
- \*No. 471. Eggs and Their Value as Food. Price 5 cents.
- \*No. 561. Feed Cost of Egg Production. Price 10 cents.
- No. 565. How to Candle Eggs.
- \*No. 657. Wheatless Ration for the Rapid Growth of Flesh on Young Chickens. Price 5 cents.
- \*No. 663. The Installation and Equipment of an Egg Breaking Plant. Price 5 cents.
- \*No. 664. The Prevention of Breakage of Eggs in Transit When Shipped in Carload Lots. Price 20 cents.
- \*No. 672. The Duck Sickness in Utah. Price 10 cents.
- \*No. 702. Efficiency of Commercial Egg Candling. Price 5 cents.
- \*No. 720. Food Habits of the Mallard Duck in the United States. Price 5¢.
- \*No. 775. Commercial Preservation of Eggs by Cold Storage. Price 10 cents.

YEARBOOK SEPARATES:

- \*No. 591. The Handling of Poultry Dressed, A Thousand Miles from the Market. Price 15 cents.
- \*No. 596. How the Produce Dealer May Improve the Quality of Poultry and Eggs. Price 5 cents.

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\*These bulletins may be obtained only from the Superintendent of Documents Government Printing Office, Washington, D. C., at the prices indicated. (Stamps not accepted).







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 25.

CASTOR OIL

*void*  
*Special*  
(prepared during war)  
March, 1918. and  
no

DESCRIPTION, METHOD OF MANUFACTURE, ETC.

TAKEN FROM GENERAL & INDUSTRIAL CHEMISTRY, BY DR. ETTORRE MOLINARI (1913),  
PAGES 398-399 (P. Blackiston's & Son Co., Philadelphia, Pa.)

" Castor Oil is extracted from the seeds of Ricinus communis, a plant cultivated in India, Italy, Messina, California, Egypt, and Greece. The oval seeds are 10 to 15 mm. long, about 6 mm. broad, and rather flat, and are covered with a brownish or marbled, shining, brittle skin; when peeled they contain 45 to 55 per cent of oil.

The oil was at one time extracted by pressing the ground seeds twice in the dry state and then pressing the residue after steeping in hot water. Nowadays, however, three consecutive pressings of the hot crushed seeds with increasing pressure are employed, modern hydraulic presses being used. This procedure yields first a fairly pure pale oil, then one less pure, and finally a more highly coloured oil for secondary industrial purposes. One hundred kilos of the seeds yield 9 kilos of husks, 43 of residual cake, 20 of oil of the first, 10 of the second, and 8 of the third pressing. The oil is purified by heating with an equal volume of boiling water, which precipitates many protein and gummy substances; it is decolorized by means of bone-black or by the ordinary processes given for tallow.

The refined oil is almost colourless or faintly yellow, and has a high specific gravity, considerable viscosity, and a peculiar, unpleasant taste and smell. It forms an excellent purgative, the less pure qualities being used in the manufacture of sulphuricinate (see p. 327) and of transparent soaps capable of retaining considerable quantities of water. Its soap differs from others in not rendering the water opalescent. The residual cake, whether extracted with carbon disulphide or not, is injurious and can not be used as cattle-food, but it is of value as manure, since it contains 4 to 5 per cent of combined nitrogen and is sold at 8s. to 10s. per quintal.

Castor oil contains various glycerides but is free from tripalmitin. Triricinolein is solid, and there appear to be glycerides of a ricinoleic acid and of a ricinisoic acid, (also of a hydroxystearic acid (melting at 141° to 143°) and a dihydroxystearic acid (which explains the characteristic high acetyl number of castor oil)).

The oil yields, besides ricinoleic acid, more or less highly polymerised compounds with less and less marked acid characters (e.g. ricinisoic acid), these increasing in amount with the age of the oil.

Castor oil is strongly dextro-rotatory (40.7° in 20 mm. tube). Unlike other oils, it is soluble in all proportions in absolute alcohol and in glacial acetic acid; at 15° it dissolves in 2 parts of 90 per cent alcohol or 4 parts of 84 per cent alcohol, but is insoluble in light petroleum or paraffin oil



CASHEW OIL

DESCRIPTION, METHOD OF MANUFACTURE, ETC.

TAKEN FROM ORIGIN & INDUSTRIAL CHEMISTRY, BY DR. FREDERICK M. WILSON (1913),  
PAGES 329-330 (P. Richardson & Son Co., Philadelphia, Pa.)

Cashew oil is extracted from the seeds of *Anacardium occidentale*, a plant cultivated in India, Italy, Hawaii, California, Egypt, and Greece. The seeds are 10 to 15 mm. long, about 6 mm. broad, and rather flat, and are covered with a brownish or marbled, shining, brittle skin; when peeled they contain 45 to 55 per cent of oil.

The oil was at one time extracted by pressing the ground seeds twice in the dry state and then pressing the residue after steeping in hot water. However, these successive pressings of the hot ground seeds with increasing pressure are employed, modern hydraulic presses being used. This procedure yields first a fairly pure pale oil, then one less pure, and finally a more highly colored oil for secondary industrial purposes. One hundred kilos of the seeds yield 5 kilos of kernel, 45 of residual cake, 30 of oil of the first, 10 of the second, and 5 of the third pressing. The oil is purified by heating with an equal volume of boiling water, which precipitates many proteins and gummy substances; it is decolorized by means of bone-black or by the ordinary process given for tallow.

The refined oil is almost colorless or faintly yellow, and has a high specific gravity, considerable viscosity, and a peculiar, unpleasant taste and smell. It forms an excellent preservative, the loss of pure qualities being small in the manufacture of *carboxylates* (see p. 337) and of transparent soaps capable of retaining considerable quantities of water. The seed differs from others in not rendering the water emulsified. The residual cake, whether extracted with carbon disulfide or not, is laxative and can not be used as cattle-feed, but it is of value as manure, since it contains 4 to 5 per cent of combined nitrogen and is sold at 25 to 100 per cent.

Cashew oil contains various glycerides but is free from triolein. *Tristearin* is solid, and there appear to be glycerides of a *pentadecanoic acid* and of a *heptadecanoic acid*. Also of a *hydroxybutyric acid* (melting at 140 to 145°) and a *dihydroxybutyric acid* (which explains the characteristic high viscosity of cashew oil).

The oil yields, besides ricinoleic acid, more or less highly polymerized compounds with less and less marked acid characters (e.g. *tristearic acid*). These increasing in amount with the age of the oil.

Cashew oil is strongly dextro-rotatory (40° in 20 mm. tube). Unlike other oils, it is soluble in all proportions in absolute alcohol and in ether; it dissolves in 2 parts of 90 per cent alcohol or 4 parts of 84 per cent alcohol, but is insoluble in light petroleum or paraffin oil.



DESCRIPTION, METHOD OF MANUFACTURE, ETC. - (CONT'D)

(both of which dissolve all other oils and fats). Hence, if a castor oil is insoluble in light petroleum and gives a clear solution with 5 vols. of 90 per cent alcohol, it may be regarded as pure. The solubility relations are completely inverted if it is heated to 300° and 10 to 12 per cent of it distilled; there then remains a produce termed floricin, which solidifies at -20°, is insoluble in alcohol, dissolves in all proportions in mineral oil, and forms a stable emulsion with 5 parts of water. A similar produce is also obtained by heating castor oil to 200° in presence of 1 per cent of formaldehyde; if heated with zinc chloride solution, it becomes dense. The potassium salt of the condensed product, with water and formaldehyde, gives a disinfectant solution producing the same effects as lysoform or ozoform.

The constants of castor oil are given in the Table on p. 378."

PHYSICAL AND CHEMICAL CONSTANTS OF CASTOR OIL, Page 378 - MOLINARI.

|                                                    |                 |
|----------------------------------------------------|-----------------|
| Specific gravity at 15° . . . . .                  | 0.9600 - 0.9679 |
| Solidifying point - Fat. . . . .                   | -10° to -18°    |
| " " - Fatty acids . . . . .                        | 5° to 10.5°     |
| Melting point - fat. . . . .                       |                 |
| " " - Fatty acids . . . . .                        | - 13°           |
| Behner number . . . . .                            | 94              |
| Acetyl number . . . . .                            | 147 to 150      |
| Reichert-Meissi-Wollny number . . . . .            | 1.4 to 2.8      |
| Saponification number, mgrms. KOH - Fat. . . . .   | 183 to 186      |
| " " " " - Fatty acids. . . . .                     | 193             |
| Iodine number - Fat. . . . .                       | 83 to 86        |
| " " - Fatty acids . . . . .                        | 87 to 93        |
| Maugenè' number - Fat. . . . .                     | 87 to 46.5      |
| Butyro-refractometer - Fat. . . . .                | 78 at 25°       |
| Index of refraction at 60° - Fatty acids . . . . . | 1.4546          |

VEGETABLE OILS, Pages 390-394 - MOLINARI.

"In plants oils accumulate especially in the seeds and the fleshy parts of the fruit, rarely in the roots. The composition of these oily parts varies somewhat with the locality and with the character of the season." \*\*\*\*\*

"The oil is extracted by two processes: by pressure and by means of solvents. Edible oils are always obtained by the former method, as also are most of the others, solvents being used to extract the remaining oil from the pressed residues (oil-cake), when these are not to be used for cattle-food.

According to the power and degree of perfection of the pressing appliances, from one-fourth to one-seventh of the total oil is left in the cake. Extraction of the powdered cake with solvents removes all but the fiftieth part of the total amount of oil (1 to 2 per cent instead of 10 to 12 per cent).

The seeds are not worked up immediately after gathering, but are first matured, dried, and turned in bins or silos .. They are then cleaned with sieves and fans, crushed in a kind of roller press (similar to that shown in Fig. 212, p. 251) and powdered (sometimes this is done directly) in vertical cast-iron or



DESCRIPTION OF METHOD OF MANUFACTURE, ETC. - (CONT'D)

(both of which dissolve all other oils and fats). Hence, it is a carrier oil in insoluble in light petroleum and gives a clear solution with 5 vols. of 90 per cent alcohol. It may be regarded as pure. The solubility relations are completely inverted if it is heated to 300° and 10 to 15 per cent of it distilled; there then remains a product termed lignin, which solidifies at 200°, is insoluble in alcohol, dissolves in all proportions in mineral oil, and forms a stable emulsion with 5 parts of water. A similar process is also obtained by heating carrier oil to 300° in presence of 1 part cent of formaldehyde; it heated with zinc chloride solution, it becomes denser. The potassium salt of the condensed product, with water and formaldehyde, gives a distinct solution producing the same effects as lignin or olefin. The constants of carrier oil are given in the table on p. 328.

PHYSICAL AND CHEMICAL CONSTANTS OF CASTER OIL, PAGE 328 - CONTINUED

|                                          |                 |
|------------------------------------------|-----------------|
| Specific gravity at 15°                  | 0.9200 - 0.9275 |
| Solidifying point - Fat                  | -100 to -120    |
| " - Fatty acids                          | 50 to 10.50     |
| Boiling point                            | 130             |
| " - Fat                                  | 24              |
| " - Fatty acids                          | 147 to 150      |
| Refractive number                        | 1.4 to 1.5      |
| Acid number                              | 1.5 to 2.5      |
| Saponification number, ester - Fat       | 182 to 186      |
| " " " - Fatty acids                      | 192             |
| Reduction number - Fat                   | 82 to 86        |
| " " - Fatty acids                        | 87 to 92        |
| Refractive number - Fat                  | 87 to 88.5      |
| Refractive number - Fatty acids          | 78 to 80        |
| Index of refraction at 60° - Fatty acids | 1.466           |

VEGETABLE OILS, Pages 320-324 - CONTINUED

The plant oils accumulate especially in the seeds and the fleshy parts of the fruit, rarely in the roots. The composition of these oily parts varies with what with the locality and with the character of the season.

The oil is extracted by two processes: by pressure and by means of solvents. Edible oils are always obtained by the former method, as also are most of the others, solvents being used to extract the remaining oil from the pressed residue (oil-cake), when these are not to be used for cattle-feed.

According to the power and degree of pressure of the pressing machine from one-fourth to one-seventh of the total oil is left in the cake. Extraction of the pressed cake with solvents removes all but the fifth part of the total amount of oil (1 to 8 per cent instead of 10 to 15 per cent).

The seeds are not worked up immediately after gathering, but are first matured, dried, and stored in bins or silos. They are then cleaned with air and fans, crushed in a kind of roller press (similar to that shown in fig. 231, p. 231) and powdered (sometimes this is done directly) in vertical condition.



stone mills like that illustrated in Fig. 210 on p. 251. A mill with a diameter of 1.7 metre converts about 35 litres of linseed into flour in twenty-five minutes.

To obtain the edible and so-called virgin oil, the flour is pressed cold, although more commonly the pressing is carried out in the hot, this increasing the yield but injuring the quality and colour.

Nowadays the pressing is effected almost everywhere with hydraulic presses of various forms, and only in small works are wooden or metal screw-presses still employed.

A hydraulic press which is widely used in the ring-press of Brink and Hübner of Mannheim, shown in Fig. 261. The powdered seeds are placed on the rings, *a*, the base of which consists of a movable, perforated steel plate covered with a disc of woolen or horsehair material. The flour is well pressed by hand or by a suitable machine, covered with a second woolen or horsehair disc, and passed along the guides, *b*, being thus brought between two plates, *c*, which are smooth underneath and grooved on the top and fit exactly into the two rings containing the flour, one above and the other below. The grooved side of the plate has also a circular, peripheral channel which collects the oil issuing from the perforated base of each of the rings when the press is working.

The automatic changing of the rings requires 1 to 2 minutes, about the same length of time being occupied in discharging them, while, under a pressure of 200 to 300 atmos., the pressing is complete in 8 to 10 minutes. Especially with palm oil and coco-nut oil, the pressing may be carried out in the hot, the plates being arranged so that they can be heated; this procedure shortens the time of pressing and increases the yield of oil. In some cases the pressing is carried out first at a low pressure, which gives an oil of improved quality, the cake thus obtained being ground (e.g. by an Excelsior mill, p. 168) and squeezed under a high pressure for the extraction of a further quantity of oil of lower grade.

Extraction of the oil by means of solvents (first attempted in England in 1856), from the crushed seeds or broken cake, is effected with carbon disulphide (see vol. 1, p. 396) --which has considerable solvent action on fats, even in the cold, but also removed a certain amount of chlorophyll-- or with light petroleum (benzine), which exerts its maximum solvent effect in the hot. The use of carbon tetrachloride has also been suggested recently (see vol. 1, page 378), since it is not inflammable like the other two solvents and, further, allows of the extraction of the oil from moist substances.

The extraction can be carried out by direct exhaustion or by systematic exhaustion. In the former case, the substance is treated with pure solvent, so that large quantities of dilute solutions which must be concentrated are obtained; in the other process, a number of apparatus are arranged in a series so that the solvent passes from one to the other and leaves the last completely saturated, while the first apparatus, as it becomes exhausted, is charged with fresh material and placed last in the series (see vol. 1, p. 470, and exhaustion of beet in the diffusers, under the heading Sugar, later). From the saturated solution of the oil, the solvent is distilled by means of direct or indirect steam and is thus completely recovered, while the crude fat remaining is refined.



stone with the first illustrated in Fig. 10 or 11. A mill with a diameter of 1.7 meters operates about 25 times in 10 minutes in twenty-five minutes.

To obtain the oil and so-called virgin oil, the first is pressed cold, although more commonly the pressing is carried out in the hot, this increasing the yield but lowering the quality and color.

However the pressing is effected almost everywhere with hydraulic pressure of various forms, and only in small works are models of metal screw-presses still employed.

A hydraulic press which is widely used in the ring-press of India and India of Kanchi, shown in Fig. 10. The powdered seeds are placed on the ring, the base of which consists of a movable, perforated steel plate covered with a disc of woolen or horsehair material. The flour is well pressed by hand or by a suitable machine, covered with a second woolen or horsehair disc, and pressed along the guides, the being thus brought between two plates, A, which are smooth underneath and grooved on the top and fit exactly into the two rings containing the flour, one above and the other below. The grooved side of the plate has also a circular, peripheral channel which collects the oil flowing from the perforated base of each of the rings when the press is working.

The automatic working of the rings requires 1 to 2 minutes, about the same length of time being required in discharging them, while, under a pressure of 200 to 300 atmos., the pressing is complete in 5 to 10 minutes. Frequently with palm oil and coconut oil, the pressing may be carried out in the hot, the plates being arranged so that they can be heated; this procedure shortens the time of pressing and increases the yield of oil. In some cases the pressing is carried out first at a low pressure, which gives an oil of improved quality, the seeds then subjected being known (e.g., by an English mill, p. 166) and repeated under a high pressure for the extraction of a further quantity of oil of lower grade.

Extraction of the oil by means of solvents (first attempted in England in 1800). From the crushed seeds or broken cake, is extracted with carbon disulfide (see vol. I, p. 192) — which has considerable solvent action on fats, even in the cold, but also removes a certain amount of chlorophyll — or with light petroleum (benzene), which extracts the maximum solvent effect in the hot. The use of carbon tetrachloride has also been suggested recently (see vol. I, p. 192), since it is not inflammable like the other two solvents and, further, allows of the extraction of the oil from moist substances.

The extraction can be carried out by direct extraction or by successive extraction. In the former case, the substance is treated with pure solvent, so that large quantities of dilute solutions which must be concentrated and obtained; in the latter process, a number of operations are arranged in a series so that the solvent passes from one to the other and leaves the last completely exhausted, while the first is evaporated, as it becomes exhausted, is mixed with fresh material and placed last in the series (see vol. I, p. 192), and exhausted of heat in the stillness, when the handling (e.g., Japan). From the exhausted solution of the oil, the solvent is distilled by means of steam or reduced to and is thus completely recovered, while the crude fat remaining is refined.



There are various forms of apparatus corresponding with the first method of extraction, such as the Mers universal extractor, that of Pallenberg, and the Wegelin and Hubner (Fig. 364) form, which is fairly widely used. In the last of these the fatty material is placed in the vessel, A, into which solvent is introduced from D by means of the tube, r<sub>q</sub>. The solvent saturated with fat is discharged into the still, C, where, by means of indirect steam passing through the coil, y, the solvent is distilled, its vapour ascending the tube, i, and condensing in B, and the liquid collecting in D. The fat remaining in C can then be drawn off through the tap, x, but if it retains solvent tenaciously, it is first heated by a current of direct steam, solvent and water then condensing together in the condenser, B; owing to their mutual insolubility, these two liquids can be separated by means of a suitable separator situated at y between B and D, the water being thrown out. If the solvent saturated with fat, instead of being drawn off by the tube, u, is caused to rise to the top of the tube, l, whence it falls into the tube, v, the extraction is effected with continuous circulation of the solvent until the substance is exhausted. To expel and recover the solvent retained by the substance remaining in A, a current of direct steam is passed into the latter; this carries off the vaporised solvent along the tube, k, through the valve, n, to the cooling coil, B, the condensed water and oil being passed through the separator, g, before the latter liquid is collected in D.

Large works, however, always use batteries of extraction apparatus arranged in series.

In a good extracting plant, the loss of solvent does not usually exceed 0.5 per cent of the weight of oil extracted and is always less than 1 per cent.

TAKEN FROM THE ENCYCLOPEDIA BRITANNICA.

**Castor Oil:** "The oil is obtained from the seeds by two principal methods -- expression and decoction-- the latter process being largely used in India, where the oil, on account of its cheapness and abundance is extensively employed for illuminating as well as for other domestic and medicinal purposes. The oil exported from Calcutta to Europe is prepared by shelling and crushing the seeds between rollers. The crushed mass is then placed in hempen cloths and pressed in a screw or hydraulic press. The oil which exudes is mixed with water and heated till the water boils, and the mucilaginous matter in the oil separates as a scum. It is next strained, then bleached in the sunlight and stored for exportation. A considerable quantity of castor oil of an excellent quality is also made in Italy, and in California the manufacture is conducted on an extensive scale. The following is an outline of the process adopted in a Californian factory. The seeds are submitted to a dry heat in a furnace for an hour or thereby, by which they are softened and prepared to part easily with their oil. They are then pressed in a large powerful screw-press and the oily matter which flows out is caught, mixed with an equal proportion of water, and boiled to purify it from mucilaginous and albuminous matter. After boiling about an hour, it is allowed to cool, the water is drawn off, and the oil is transferred to zinc tanks or clarifiers capable of holding from 60 to 100 gallons. In these it stands about eight hours, bleaching in the sun, after which it is ready for storing. By this method 100 lbs. of good seeds yield about 5 gallons of pure oil.



There are various forms of apparatus corresponding with the first method of extraction, such as the Soxhlet extractor, that of Williams and the Soxhlet and others (Fig. 304). In the Soxhlet, which is fairly widely used, the last of these the fatty material is placed in the vessel, A, into which solvent is introduced from B by means of the tube, C. The solvent is discharged into the still, D, where, by means of indirect steam passing through the coil, Y, the solvent is distilled, its vapour ascending the tube, A, and condensing in E, and the liquid collecting in F. The fat retained in C can thus be drawn off through the tap, Z. As it retains solvent continuously, it is first heated by a current of direct steam, solvent and water then condensing together in the condenser, H, owing to their mutual insolubility, these two liquids can be separated by means of a suitable separator attached at G between B and E, the water being drawn out. If the solvent retained with fat, instead of being drawn off by the tube, G, is caused to rise to the top of the tube, I, whence it falls into the tube, W, the extraction is assisted with continuous circulation of the solvent until the substance is exhausted. As usual, however the solvent retained by the substance remaining in A, a current of direct steam is passed into the latter, this carries off the exhausted solvent along the tube, H, through the valve, G, to the cooling coil, E, the condensed water and oil being passed through the separator, A, before the liquid is collected in D.

Larger works, however, always use batteries of extraction apparatus arranged in series.

In a good extracting plant, the loss of solvent does not usually exceed 0.5 per cent of the weight of oil extracted and is always less than 1 per cent.

#### TAKEN FROM THE METHYLOXIDE METHOD.

Crude Oil: The oil is obtained from the seeds by two principal methods—extraction and decolouration—the latter process being largely used in India, where the oil, on account of its cheapness and abundance is extensively employed for illuminating as well as for other domestic and medicinal purposes. The oil extracted from Castor is known as Castor oil and is refined by the usual methods. The seeds between rollers. The crushed mass is then placed in a bag and pressed in a screw or hydraulic press. The oil which comes out is mixed with water and heated till the water boils, and the emulsion is then filtered. The oil is then strained, then filtered in the usual manner and stored for exportation. A considerable quantity of castor oil is exported from India, and in California the manufacture is conducted on an extensive scale. The following is an outline of the process adopted in a California factory. The seeds are submitted to a dry heat in a furnace for an hour or two, by which they are softened and prepared to be pressed with their oil. They are then pressed in a large pressure screw press and the oil which flows out is mixed with water and allowed to settle. After settling about an hour, it is allowed to run, the water is drawn off, and the oil is transferred to a tin tank or otherwise capable of holding from 50 to 100 gallons. In this it stands about eight hours, bleaching in the sun, after which it is ready for storing. By this method 100 lbs. of good seeds yield about 5 gallons of pure oil.



Castor oil is a viscid liquid, almost colourless when pure, possessing only a slight odour, and a mild yet highly nauseous and disagreeable taste. Its specific gravity is<sup>n</sup>.96, a little less than that of water, and it dissolves freely in alcohol, ether and glacial acetic acid. It contains palmitic and several other fatty acids, among which there is one --ricinoleic acid--peculiar to itself. This occurs in combination with glycerin, constituting the greater part of the bulk of the oil."

LUBRICANTS.- "For the spindles of small machines such as clocks, watches and other delicate mechanisms, which are only lubricated at long intervals and are often exposed to extremes of temperature, the lubricant must be a fluid oil as free as possible from tendency to gum or thicken by oxidation or to corrode metal, and must often have a low freezing-point. It must also possess a maximum of "oiliness". The lubricants mostly used for such purposes are obtained from porpoise or dolphin jaw oils, bean oil, hazel nut oil, neatsfoot oil, sperm oil, or olive oil. These oils are exposed for sometime to temperatures as low as the mechanism is required to work at, and the portion which remains fluid is separated and used. Free acid should be entirely eliminated by chemical refining. A little good mineral oil may, with advantage, be mixed with the fatty oil."

Castor oil is being extensively used as a high grade vegetable oil for use with automobiles, aeroplanes, etc.

TAKEN FROM LUBRICATING ENGINEERS' HANDBOOK, BY J. R. BATTLE (J.B.Lippincott Company, New York), Page 51.

"Viscosity of Castor Oil. - An idea of the effect of temperature rise, on the viscosity of chemically pure castor oil, may be obtained from the following figures (obtained from an average sample):-

| 100° Fahr. | ... | Vis. | Say | 1200 seconds |
|------------|-----|------|-----|--------------|
| 125°       | "   | "    | "   | 600 "        |
| 150°       | "   | "    | "   | 300 "        |
| 175°       | "   | "    | "   | 175 "(       |
| 200°       | "   | "    | "   | 110 "        |
| 250°       | "   | "    | "   | 60 "         |
| 300°       | "   | "    | "   | 40 "         |

TAKEN FROM DICK'S ENCYCLOPEDIA OF PRACTICAL RECEIPTS AND PROCESSES.

"To Test the Purity of Castor Oil. - Castor oil is frequently adulterated with rape-oil; but this may be detected by its not dissolving in strong alcohol, and also by its less density. Pure castor oil is soluble in an equal weight of alcohol specific gravity 0.820."

"To Purify and Sweeten Castor Oil. - The American Journal of Pharmacy gives the following receipt for this purpose: Take 1,000 parts of the oil, 25 parts purified bone-black, 10 parts of calcined magnesia. Mix them carefully in a convenient vessel of glass or tinned iron, and let it stand during 3 days, with occasional agitation, and filter through paper of felt."



Gasoline oil is a white liquid, almost colorless when pure, possessing only a slight odor, and a mild but highly persistent and disagreeable taste. Its specific gravity is 0.72, a little less than that of water, and it dissolves freely in alcohol, ether and essential oils. It contains paraffin and several other fatty acids, many of which there is one - stearic acid - coming in itself. This occurs in combination with glycerol, constituting the glyceride part of the oil of the oil.

IMPORTANCE - For the application of small machines such as clocks, watches and other delicate mechanisms, which are only intended as long intervals and are often exposed to extremes of temperature, the lubricant must be a fluid oil as free as possible from tendency to gum or thicken by oxidation as to viscosity itself, and must often have a low freezing-point. It must also possess a maximum of "stability". The lubricants mostly used for such purposes are obtained from petroleum or kerosene, gas oil, kerosene, kerosene oil, kerosene oil, kerosene oil, or olive oil. These oils are exposed for oxidation to kerosene as far as the mechanism is required to work, and the portion which remains fluid is separated and used. These oils should be entirely eliminated by chemical refining. A little good mineral oil may, with advantage, be mixed with the fatty oil.

Gasoline oil is being extensively used as a high grade vegetable oil for use with automobiles, motorcycles, etc.

FROM THE INVESTIGATIONS OF THE BUREAU OF STANDARDS, WASHINGTON, D. C. (4-11-1911)

Company, New York, Page 51.

Viscosity of Gasoline Oil - An idea of the effect of temperature rise on the viscosity of chemically pure motor oil, may be obtained from the following figures (obtained from an average sample):

| Temperature | Viscosity | Specific Gravity |
|-------------|-----------|------------------|
| 100°        | 100       | 0.72             |
| 120°        | 80        | 0.72             |
| 140°        | 60        | 0.72             |
| 160°        | 45        | 0.72             |
| 180°        | 35        | 0.72             |
| 200°        | 25        | 0.72             |
| 220°        | 15        | 0.72             |
| 240°        | 10        | 0.72             |

FROM THE BUREAU OF STANDARDS, WASHINGTON, D. C. (4-11-1911)

"To test the purity of Gasoline Oil - Gasoline oil is frequently adulterated with kerosene; and this may be detected by its not dissolving in strong alcohol, and also by its low density. The motor oil is soluble in an equal weight of alcohol specific gravity 0.835."

"To purity and standard Gasoline Oil - The American standard of purity gives the following method for this purpose: Take 1,000 parts of the oil, 25 parts purified benzene, 10 parts of colored magnesia. Mix them carefully in a well-shaken vessel of glass or stoneware, and let it stand during 3 days, with occasional agitation, and filter through paper of 101."



PARTIAL LIST OF MANUFACTURERS OF HYDRAULIC PRESSES.

|                                |                        |
|--------------------------------|------------------------|
| Allis-Chalmers Mfg. Co.,       | Milwaukee, Wisconsin.  |
| Blymer Iron Works Co.,         | Cincinnati, Ohio.      |
| Chas. F. Elmers Engine Works,  | Chicago, Ill.          |
| The Hydraulic Press Mfg. Co.,  | Mount Gilead, Ohio.    |
| Louisville Drying Machine Co., | Louisville, Ky.        |
| Sam'l. L. Moore & Sons, Corp., | Elizabeth, New Jersey. |
| Wm. R. Perrin Co.,             | Chicago, Ill.          |
| Presey & Jones Co.,            | Wilmington, Del.       |
| Geo. L. Squier Mfg. Co.,       | Buffalo, New York.     |
| Henry Vogt Machine Co.,        | Louisville, Ky.        |

PARTIAL LIST OF REFINERS OR HANDLERS OF CASTOR OIL. (McKee's Blue Book,  
Railway Exchange, Chicago, Ill.)

|                            |                       |
|----------------------------|-----------------------|
| Cook, W. B. Oil Co.,       | New York City.        |
| Ensign Oil Co.,            | San Francisco, Calif. |
| Fuerst Bros. & Co.,        | New York City.        |
| Fuller-Morrison Co.,       | Chicago, Ill.         |
| Hollingshead, R.M. Co.,    | Chicago, Ill.         |
| Indian Refining Co., Inc.  | New York City.        |
| Jones, E. F. Chemical Co., | New York City.        |
| Marshall Oil Co.,          | Marshalltown, Iowa.   |
| Millets, A. D., Sons. Co.  | Pittsburgh, Pa.       |
| National Lead Co.,         | New York City.        |
| Paragon Refining Co.,      | Toledo, O.            |
| Sun Co.,                   | Philadelphia, Pa.     |







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

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DAMP-PROOFING METHODS

No waterproofing preparation can make amends for a concrete that is not dense and uniform throughout. Many existing structures permit water to penetrate the walls or have damp walls which must be remedied. In certain cases heavy water pressures must be resisted while in others all that is necessary is to prevent the penetration of moisture by capillary action.

A practically watertight concrete can be made, without the use of any extraneous material, which will resist hydrostatic heads up to 40 feet. In order to secure such an impermeable concrete strict attention must be paid to the details of proportioning, mixing, placing and curing. Directions for making good concrete are given in Farmers' Bulletin 1279, "Plain Concrete for Farm Use." A copy of this bulletin may be obtained from the Office of Publications, Department of Agriculture, Washington, D. C., as long as the supply lasts.

Although concrete can be made practically waterproof, no concrete as ordinarily made will be entirely so. On this account there are in use many materials and devices for making concrete impervious to moisture. These waterproofing schemes seldom if ever add strength to the concrete and many methods damage the cement, making the concrete less durable. However, waterproofing is required at times and may often be wisely done on the face of the concrete or incorporated in the whole body of the concrete. The various processes used to waterproof or damp-proof concrete consist of: incorporating a substance or preparation designed to reduce its porosity either by filling the voids or repelling the moisture; or else applying coatings, plasters or washes to the surface. Existing structures are waterproofed by one of the latter methods. Frequently some integral material is incorporated with plaster or wash coats.

In addition to the substances sold under trade names the following materials are in common use:

Hydrated Lime.

Hydrated lime is easily handled and is perhaps one of the best materials to use for filling voids. It is especially desirable in lean mixtures which it seems to strengthen and lubricate thus facilitating placing of mortar. The amount of lime used should not exceed 10% of the weight of the cement. Ordinarily it is much more desirable to purchase extra cement instead of hydrated lime and use a richer mixture.







The two following preparations form insoluble compounds which practically fill all pores, making an impervious concrete.

Alum and Soap Mixture.

Dissolve one pound of alum in 2 gallons of water and, separately,  $2\frac{1}{4}$  pounds of soap in 8 gallons of water. Mix the two solutions, stirring frequently to prevent the compound from accumulating on the surface. The compound is used in place of the mixing water. This method of waterproofing decreases the strength of the concrete about 20%.

Lime and Soap Mixture.

Dissolve  $\frac{1}{4}$  pound of soap per gallon of water and add  $\frac{1}{2}$  oz. of unslaked lime. Stir the mixture thoroughly to keep in suspension the calcium soap formed. The solution is used in place of the mixing water.

----- " -----

Lye and Alum Mixture.

A process said to be effective 12 years after application, is as follows:

Dissolve one pound of concentrated lye and 5 pounds of alum in 2 gallons of water, care being taken that every particle is dissolved. Heating to near the boiling point will insure this without injury to the mixture. This constitutes the stock which may be made up in any quantity in the same proportions. To one pint of the stock add 10 pounds of cement thinning out with water until the mixture spreads well with a whitewash brush, lathering freely and filling all pores in the surface. Usually 1 pint of the stock and 10 pounds of cement thoroughly mixed in a 12 quart pail with enough water to well fill the pail makes the wash about right. If the surface to be treated is dry it should be sprayed with water just before the wash is applied. The wash is best applied to the concrete three or four days after it is cast and while it is being kept wet in curing; a few hours are sufficient for the wash to harden enough to stand a spray. The wash is not satisfactory for old work, but is especially adapted to waterproofing concrete block and stucco. Sometimes 1 part of this stock to 30 parts water is used in place of mixing water in making 1:2 mortar for facing; this waterproofs the surface and leaves the face free from brush marks.

----- " -----

Oil Mixed Portland Cement Concrete.

Tests have shown that a heavy mineral residual oil, when incorporated with concrete mixtures is very effective in making the concrete non-absorbent, however, the addition of this oil does not increase the impermeability of concrete subjected to heavy water pressure and this method alone will probably not make the concrete proof against percolation of water through the mass.



The two following preparations form insoluble compounds which practically fill all pores, making an impervious concrete.

### Alum and Soap Mixture.

Dissolve one pound of alum in 5 gallons of water and, separately,  $\frac{1}{2}$  pounds of soap in 5 gallons of water. Mix the two solutions, stir thoroughly to prevent the formation of lumps. This method of water-proofing increases the strength of the concrete about 50%.

### Lime and Soap Mixture.

Dissolve  $\frac{1}{2}$  pound of soap per gallon of water and add 5 lb. of unsifted lime. Stir the mixture thoroughly to keep in suspension the calcium soap formed. The solution is used in place of the mixing water.

### Lye and Alum Mixture.

A process said to be effective 15 years after application, is as follows:

Dissolve one pound of concentrated lye and 5 pounds of alum in 5 gallons of water, care being taken that every particle is dissolved. Boasting to meet the falling point will insure this without injury to the mixture. This constitutes the stock which may be made up in any quantity in the same proportions. To one pint of the stock add 10 pounds of cement, thinning out with water until the mixture spreads well with a whitewash brush, following freely and filling all pores in the surface. Usually 1 pint of the stock and 10 pounds of cement thoroughly mixed in a 12 quart pail with enough water to fill the pail makes the wash about right. If the surface to be treated is dry it should be sprayed with water just before the wash is applied. The wash is best applied to the concrete three or four days after it is cast and while it is being kept wet in curing; a few hours are sufficient for the wash to penetrate enough to stand a spray. The wash is not suitable for old work, but is especially adapted to waterproofing concrete block and stone. Sometimes 1 part of this stock to 50 parts water is used in place of adding water in making 1:3 mortar for facing. This waterproofs the surface and leaves the face free from stains.

### Oil Mixed Portland Cement Concrete.

Tests have shown that a heavy mineral residual oil, when incorporated with concrete mixtures is very effective in making the concrete non-permeable. However, the addition of this oil does not increase the impermeability of concrete subjected to heavy water pressure and this method alone will probably not make the concrete proof against penetration of water through the mass.



The use of such oil is described in Department Bulletin 230, "Oil-mixed Portland Cement Concrete." As this bulletin is no longer available the following abstract has been made:

Oil-mixed concrete differs from ordinary concrete only in that oil is an additional ingredient in the mixture. All oils are not suitable but any oil that meets the following specifications should prove satisfactory.

(1) The oil shall be a fluid petroleum product and shall contain no admixture of fatty or vegetable oils.

(2) It shall have a specific gravity not greater than 0.945 at a temperature of 25° C.

(3) It shall show a flash point of not less than 150° C. by the closed-cup method.

(4) When 240 cc. of the oil is heated in an Engler viscosimeter to 50° C., and maintained at that temperature for at least three minutes the first 100 cc. which flows out shall show a specific viscosity of not less than 15 nor more than 30.

(5) When 1 part of the oil is shaken up with 2 parts of hundredth normal caustic soda, there shall be no emulsification, and upon allowing the mixture to remain quiet the two components shall rapidly separate in distinct layers.

The general purpose of the above clauses is as follows:

Claude 1 eliminates compounded products in which the presence of saponifiable oils would break down the strength of the cement. Clause 5 has a similar purpose in eliminating certain straight petroleum residuals which readily emulsify with alkali, and seriously impair the strength of the mortar to which they are added. Clauses 2, 3, and 4 combine to prevent the use of certain asphaltic oils which prove detrimental to the strength of the concrete, and clause 4, in particular, prescribes an oil of such viscosity as to be readily miscible with the mortar, while still possessing sufficient body to render the structure dampproof.

As the above tests cannot be made readily outside of a laboratory the following oils are mentioned as being generally satisfactory: - Gargoyle Mobile Oils "A" and "B", Gargoyle Crank Case Oil and V. C. Oil 704, which are manufactured by the Vacuum Oil Company, 61 Broadway, New York City. These oils are rather expensive but can be obtained in small quantities which may make their use desirable.



The use of such oil is described in Department Bulletin 230, "Oil-mixed Portland Cement Concrete." As this bulletin is no longer available the following abstract has been made:

Oil-mixed concrete differs from ordinary concrete only in that oil is an additional ingredient in the mixture. All oils are not suitable but any oil that meets the following specifications should prove satisfactory.

(1) The oil shall be a liquid petroleum product and shall contain no admixture of fatty or vegetable oils.

(2) It shall have a specific gravity not greater than 0.945 at a temperature of 25° C.

(3) It shall show a flash point of not less than 180° C. by the closed-cup method.

(4) When 250 cc. of the oil is heated in an Engler viscometer to 50° C. and maintained at that temperature for at least three minutes the first 100 cc. which flows out shall show a specific viscosity of not less than 18.

(5) When 1 part of the oil is shaken up with 3 parts of Portland cement, there shall be no emulsification, and upon allowing the mixture to remain until the two components shall rapidly separate in distinct layers.

The general purpose of the above classes is as follows:

Class 1 eliminates compounded products in which the presence of emulsified oil would break down the strength of the concrete. Class 2 and 3 are a similar purpose in eliminating certain straight petroleum products which readily emulsify with alkali, and seriously impair the strength of the mortar to which they are added. Classes 2, 3, and 4 combine to prevent the use of certain asphaltic oils which prove detrimental to the strength of the concrete, and Class 5, in particular, prescribes an oil of such viscosity as to be readily miscible with the mortar, while still possessing sufficient body to render the structure gasproof.

As the above tests cannot be made readily outside of a laboratory the following oils are mentioned as being generally satisfactory: Gargyle's "Bottle Oil" "A" and "B", Gargyle's Green Oil and V. C. Oil, which are manufactured by the Vacuum Oil Company, 61 Broadway, New York City. These oils are rather expensive but can be obtained in small quantities which may make their use desirable.



Method of Making.

For most purposes where dampproofing is required 5 per cent of oil of the weight of cement in the mixture is all that is necessary. A bag of cement weighs 94 pounds, and consequently, for each bag of cement used in the mixture, 4.7 pounds or about  $2\frac{1}{2}$  quarts of oil are required.

Let it be supposed that a batch of concrete requiring two bags of cement is to be mixed in the proportions of 1 part of cement to 2 parts of sand to 4 parts of broken stone or gravel, together with 5 per cent of oil. Four cubic feet of sand are first measured out in a bottomless box, 12 inches deep and 2 feet on each side. On top of the sand is spread the cement and these materials are mixed together until they appear to be of uniform color. Water is then added to the mixture and the mass again mixed to a mortar of mushy consistency. 5 quarts of oil are then measured out and added to the mortar and the mass again turned until there is no trace of oil visible on the surface of the mortar. Particular care should be taken to continue the mixing until the oil is thoroughly incorporated in the mixture. Experience has shown that to insure the very best results the length of time of mixing should be practically double that required when oil is not used. The oil-mixed mortar is then combined with the stone or gravel previously moistened and the mass is again turned until all of the stone is thoroughly coated with the mortar and the mass is uniformly mixed throughout. Should only oil-mixed mortar be desired, the process is similar to that above described except that no stone is added.

In a machine mixer the cement, sand, and water are first mixed to a mortar, then alternate batches of oil and stone are added until the required quantity of oil is mixed, and then the remainder of the stone is added and mixed. When a batch mixer is used, the exact method of procedure should be determined by experiment, owing to the fact that different makes of mixers require slightly different handling to insure best results. A continuous mixer should not be used in oil-cement-concrete work, as with this type the time of mixing can not readily be increased to the extent necessary to insure a uniform distribution of the oil.

Materials Required for 1 Cubic Yard.

The following table gives the proportions by parts and amounts required of cement, sand, stone, and oil to make a cubic yard of oil-mixed mortar and concrete:







Quantities of materials required for 1 cubic  
yard of oil-mixed mortar and concrete.

| Proportions by Parts |                 |        |       | :                     | :      | :      | Stone                   | :     |
|----------------------|-----------------|--------|-------|-----------------------|--------|--------|-------------------------|-------|
|                      |                 |        |       | :                     | :      | :      | or                      | :     |
|                      |                 |        |       | :                     | :      | :      | Oil                     | :     |
| Cement               | Sand            | cr     | (Per  | (bbls. <sup>1</sup> ) | (Cubic | (Cubic | (gallons <sup>2</sup> ) |       |
| :                    | :               | Gravel | Cent) | :                     | Yards) | Yards) | :                       |       |
| 1                    | :               | :      | :     | 3                     | 8.31   | :      | :                       | 12.1  |
| 1                    | 2               | :      | :     | 5                     | 3.32   | 0.93   | :                       | 8.06  |
| 1                    | 3               | :      | :     | 5                     | 2.48   | 1.05   | :                       | 6.02  |
|                      |                 | :      | :     | 10                    |        |        | :                       | 12.04 |
| 1                    | 4               | :      | :     | 5                     | 1.98   | 1.11   | :                       | 4.8   |
|                      |                 | :      | :     | 10                    |        |        | :                       | 9.61  |
| 1                    | 2               | 4      | :     | 5                     | 1.57   | .44    | 0.88                    | 3.81  |
| 1                    | 2 $\frac{1}{2}$ | 5      | :     | 5                     | 1.30   | .46    | .92                     | 3.15  |
|                      |                 | :      | :     | 10                    |        |        | :                       | 6.3   |
| 1                    | 3               | 6      | :     | 5                     | 1.11   | .47    | .94                     | 2.69  |
|                      |                 | :      | :     | 10                    |        |        | :                       | 5.38  |

<sup>1</sup> One barrel of cement equals 4 bags.

<sup>2</sup> Oil weighs about 7 $\frac{3}{4}$  pounds per gallon.

A mortar made of 1 part Portland cement, 2 parts sand and 5% (2 $\frac{1}{2}$  quarts per bag) of oil may be used for the wearing coat of a basement floor; plastering the surfaces of stone, brick or concrete walls; the scratch or first coat in stucco work; and exposed surfaces of water containers.

A basement wall if made of 1:2 $\frac{1}{2}$ :5 concrete to which is added 10% of oil based on the weight of the cement should not leak; while 5% of oil added to a 1:2:4 mixture is said to produce non-absorbent concrete blocks. The mixture recommended for cisterns is 1:2:4 with 10% oil.

The general principles of building floors are given in Information Series 43, "Concrete Sidewalks, Feeding Floors, Curbs and Steps;" applying stucco is outlined in Information Series 51, "Stucco;" while Information Series 56, describes how to make concrete block. These papers can be had from the Division of Agricultural Engineering, Bureau of Public Roads, Washington, D. C.

The admixture of oil is not detrimental to the tensile strength of mortar composed of 1 part cement and 3 parts sand when the oil added does not exceed 10% of the weight of the cement used. The compression strength however suffers slightly (having 75% of plain concrete at 28 days) although when not over 10% of the oil is used the decrease in strength is not serious. Concrete mixed with oil requires a period of time from 50 to 100% longer to set hard than does plain concrete, but the increase in strength is nearly as rapid in the oil mixed material as in the plain concrete.



Quantities of materials required for 1 cubic yard of oil-mixed mortar and concrete.

| From 1 cubic yard of concrete | Concrete         |                | Mortar           |                | Oil        |               |
|-------------------------------|------------------|----------------|------------------|----------------|------------|---------------|
|                               | Gravel (cu. yd.) | Sand (cu. yd.) | Gravel (cu. yd.) | Sand (cu. yd.) | Oil (gal.) | Oil (cu. ft.) |
| 1                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 2                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 3                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 4                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 5                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 6                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 7                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 8                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 9                             | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 10                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 11                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 12                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 13                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 14                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 15                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 16                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 17                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 18                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 19                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |
| 20                            | 1.00             | 1.00           | 1.00             | 1.00           | 1.00       | 1.00          |

1 One barrel of cement equals 4 bags.

2 Oil weighs about 7.5 pounds per gallon.

A mortar made of 1 part Portland cement, 3 parts sand and 50 (50 pounds per gal.) of oil may be used for the working coat of a base-ment floor, plastering the surface of stone, brick or concrete walls; the surface of this coat is smooth rock, and exposed surface of water.

A basement wall at rate of 1:2:5 concrete in which is added 10% of oil added on the weight of the cement should not crack, while 5% of oil added to a 1:2:5 mixture is said to produce an excellent concrete blocks. The mixture recommended for concrete is 1:2:5 with 10% oil.

The general principle of building floors and walls for basements is to use a mixture of 1 part Portland cement, 3 parts sand and 50 (50 pounds per gal.) of oil. This mixture is said to be the best for basements. The mixture is said to be the best for basements. The mixture is said to be the best for basements.

The amount of oil is not determined by the relative strength of mortar composed of 1 part cement and 3 parts sand and the oil which does not exceed 10% of the weight of the cement used. The composition strength between surface and oil is 1:2:5. The mixture is said to be the best for basements. The mixture is said to be the best for basements. The mixture is said to be the best for basements.



The bond between concrete and plain-bar reinforcement is decreased by the use of oil in the concrete, but when deformed bars, wire mesh, or expanded metal is used there is no apparent decrease in bond.

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#### Membraneous Coating.

Various methods are used for coating or washing the surfaces of existing concrete structures to lessen or prevent dampness or the penetration of water. Yardbook Separate 824, "Securing a Dry Cellar," describes the method of applying a membraneous coating to walls and floors which is the most reliable but also the most expensive of methods ordinarily used. The use of tile drains is discussed and the effectiveness of interior ventilation emphasized. A membraneous coating is the only method of waterproofing recommended for use when there is a head of water to be resisted. A copy of this bulletin may be obtained from the Office of Publications, Department of Agriculture, Washington, D. C.

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Other methods commonly used in addition to plaster coats, containing the so-called integral preparations are: -

#### Cement Wash.

Several brush coats of cement and water of a creamy consistency are beneficial. Surface imperfections should be removed and the walls wet before applying the wash. Before the first coat is dry, a second coat should be applied, and this should be kept moist for several days. The wash is liable to craze or crack if exposed to the action of sun and rain, especially during the first few weeks after it is applied. The wash is very satisfactory for water containers when applied on the surfaces in contact with the water.

#### Sylvester's Wash.

Sylvester's wash has long been used for waterproofing brick work and concrete which has hardened and dried out. It consists in the alternate applications of alum and of soap solutions to the face of the wall. The alum solution is made by dissolving eight ounces of alum per gallon of water, and the soap solution by dissolving one and one-half pounds of hard soap per gallon of water. The surface should be clean and dry so that the solutions will be readily absorbed. The air temperature should not be less than 50° F. The soap solution should be applied boiling hot, while the alum solution should be about 70° F. A coat of the soap solution is first applied, using a whitewash or other convenient brush and rubbing it well into the surface but taking care not to produce a froth. This is left for 24 hours or until the surface is entirely dry. A coat of the alum solution is then applied and allowed to dry for another 24 hours. This is followed with another coat of soap and another of alum







at similar intervals. Two pairs of coats should be sufficient for any ordinary case, though additional ones may be applied if required. The effect of this treatment is to form an insoluble compound of calcium soap in the outer pores of the concrete, this soap filling the pores and acting as a water-repellent. It is one of the most effective treatments which can be given a concrete surface, however, it becomes less effective with age.

#### Paraffin Coating.

A paraffin coating may be applied either cold or hot. In either case the surface should be clean and dry. If the coating is applied hot the walls to be treated must be heated. The melted paraffin is then thoroughly rubbed in. Six and one-half pounds of paraffin makes one gallon of the melted paraffin and will cover about 250 square feet. A blow torch is convenient for heating the walls and as an aid in spreading thin layers of paraffin. In the cold process, the paraffin is dissolved in a volatile liquid such as naphtha and applied with a brush. The volatile liquid evaporates and leaves the surface appearance the same as before but with the outer pores filled with paraffin. 4 pounds paraffin dissolved in  $\frac{1}{2}$  gallon gasoline or naphtha will make one gallon of the solution. One gallon has a covering capacity of 200 square feet. At least two coats should be given. Sometimes asphalt is used in the same manner as paraffin.

#### Water Glass.

Sodium Silicate or water glass, may be applied to a surface to waterproof it. Two coats are usually sufficient. This treatment is more expensive than the soap and alum treatment and is no more effective.

#### Coal Tar.

The following directions for using coal tar are copied from the "Iowa Homestead" of April 20, 1916. The use of this material is recommended in accordance with results secured in tests conducted by the Iowa Agricultural College. 4

Heat thin coal tar to the boiling point, at which time kerosene is added in the proportion of 1 part of the latter to 8 of coal tar. Care must be taken in pouring in the kerosene, and those who use this mixture are advised not to stand close in the pouring process. Afterwards, 1 part neat cement to 8 parts of the mixture are added. Then apply with a brush to the surface that is to be waterproofed. It is said that this mixture will penetrate to a depth of 1 to 3 inches. It is entirely practical to apply this material to the interior of walls, in which case the use of rather a large proportion of cement is recommended. This mixture should not be used to waterproof the interior of cisterns as it will impart a disagreeable taste to the water. Water-glass is more commonly used but is not as effective, durable or cheap.



at similar intervals. The parts of coats should be applied for any ordinary cases though additional coats may be applied if required. The effect of this treatment is to form a flexible covering of the surface which in the outer pores of the concrete, this also fills the pores and makes a water-repellent. It is one of the most effective treatments which can be given a concrete surface, however, it becomes less effective with age.

### Isinglass Solution

A partially dissolved isinglass may be applied either cold or hot in either case the surface should be clean and dry. It is one of the most effective treatments which can be given a concrete surface, however, it becomes less effective with age. The isinglass is dissolved in water and the solution is applied to the surface of the concrete. It is one of the most effective treatments which can be given a concrete surface, however, it becomes less effective with age. The isinglass is dissolved in water and the solution is applied to the surface of the concrete. It is one of the most effective treatments which can be given a concrete surface, however, it becomes less effective with age.

### Water Glass

Sodium Silicate or water glass, may be applied to a concrete surface in the form of a solution. The solution is made by dissolving the water glass in water. It is one of the most effective treatments which can be given a concrete surface, however, it becomes less effective with age.

### Coal Tar

The following directions for using coal tar are contained in the "Journal of the American Society of Civil Engineers" for April 1918. The use of this material is recommended in accordance with various recommendations made by the Iowa Agricultural College. Heat this coal tar to the boiling point, at which time it should be added in the proportion of 1 part of the oil to 3 parts of water. Care must be taken in pouring it on the surface, and those who use this mixture are advised not to stand close in the pouring process. The mixture is divided into 3 parts of the mixture and about 1 part is added to the surface. The mixture is applied with a brush to the surface. It is one of the most effective treatments which can be given a concrete surface, however, it becomes less effective with age.



U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

Information Series - No. 27

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VENTILATION OF FARM STRUCTURES

THE VENTILATION OF FARM BUILDINGS.

Small buildings are usually ventilated through the window, which should be fitted with some means of preventing drafts in cold weather. In poultry houses light wooden frames covered with thin cloth are hung in place of glass sash, but are left open except in bad weather. The cloth admits enough air for the chickens, but prevents drafts.

Since these cloth screens would not admit sufficient air for larger animals other means must be used for ventilating barns. Where only a few animals are kept sufficient ventilation is usually provided by hinging the window sash at the bottom of the frame so that they will swing inward at the top. Triangular pieces of wood, metal, or cloth are then fastened to the sides of the window frame, and where cloth is used, to the sash also. Thus the air is directed upward and over the animals so that drafts do not strike them.

Where fifteen or more cattle or horses are kept in one barn, ventilating flues should be provided in addition to windows. Prof. King of Wisconsin, was the first to advocate the use of ventilating flues in farm buildings, and most of the systems now in use in this country are built after his plan. Prof. King's experiments led him to think that the injurious part of the respired air settled to the floor and it should be removed by flues running from the floor to the roof. Fresh air, according to his theory, should enter at the top of the stable to avoid drafts and his system was designed with this in view. A full description of this system is given in Bulletin 164 of the Wisconsin Experiment Station at Madison, Wisconsin.

In Canada it was found that the great problem in ventilating farm buildings was to get rid of the moisture from the breath of the cattle before it condensed on walls and ceilings, forming frost. The warm, moist air from the lungs of the cattle is, of course, lighter than the cold air of the stable and tends to rise to the ceiling. In order to get rid of it as soon as possible, the Canadian authorities start their outlet flues at the ceiling, extending them up through the roof. The fresh air is brought into the stable at the ground line. This is known as the Rutherford System, and is fully described in Bulletin 78 of the Dominion Experiment Farm, Ottawa, Canada, under the title of "Ventilation of Farm Buildings", also in Bulletin 13 of the Manitoba Agricultural College, Winnipeg, Canada, entitled "Barn Ventilation."

In the Transactions of the American Society of Agricultural Engineers, Vol. 8, there is a very good comparison of these two systems of ventilation. This report may be obtained from Mr. H. C. Ramsower, Secretary Association, Ohio State Agricultural College, Columbus, Ohio.

Recent experiments of the New York and Chicago Boards of Health and other authorities, both in this country and abroad, show that the important problem of ventilation is the control of the moisture content and temperature of the air.







## FRUIT AND VEGETABLES

Farmers' Bulletin 903, "Commercial Evaporation and Drying of Fruits", by James H. Beattie, and H.P. Gould, 1917, 60 pages, 22 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Several drawings and photographs showing methods of ventilating evaporator kilns.

Farmers' Bulletin 879, "Home Storage of Vegetables", by James H. Beattie, 1917, 22 pages, 20 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Bulletin contains several plans for storage cellars, showing ventilation systems.

Farmers' Bulletin 852, "Management of Common Storage Houses for Apples in the Pacific Northwest", by H. J. Ramsey and S. J. Dennis, 1917, 23 pages, 4 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Drawings in the bulletin show cross-section of a common storage house showing how air circulates, (a) when the temperature of the air outside is lower than the temperature of the product stored in the storage room; and (b) when the temperature of the air outside the house is higher than the temperature of the product stored in the storage room.

Farmers' Bulletin 847, "Potato Storage and Storage Houses", by William Stuart, 1917, 27 pages, 20 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Bulletin contains several plans and photographs showing ventilation of storage cellars.

Farmers' Bulletin 543, "Storing and Marketing Sweet Potatoes", by H. C. Thompson, 1913, reprinted 1917, 15 pages, 9 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Bulletin contains plans of sweet potato houses showing ventilation system.

## LIVESTOCK:

Farmers' Bulletin 438, "Hog Houses", by J. A. Warren, 1915, 29 pages, 21 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Several drawings of hog houses showing the ventilation.

Farmers' Bulletin 574, "Poultry House Construction", by Alfred R. Lee, 1914, 20 pages, 13 figs. Obtainable from Division of Publications, U. S. Department of Agriculture. Bulletin contains photographs and drawings of poultry houses some of which show the ventilation of the house.

Farmers' Bulletin 810, "Equipment for Farm Sheep Raising", by V. O. McWhorter, 1917, 27 pages, 37 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture, page 7, Discussion of Ventilating Sheep Barns.

## MISCELLANEOUS:

Farmers' Bulletin 623, "Icehouses and the Use on the Dairy Farm", by John T. Bowen, and Guy M. Lambert, 1915, 24 pages, 10 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Bulletin contains several drawings showing proper ventilation of icehouses.

Farmers' Bulletin 523, "Tobacco Curing", by W. W. Garner, 1913, 24 pages, 4 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Description (with illustration of tobacco curing shed showing ventilation).

Farmers' Bulletin 463, "The Sanitary Privy", by C. W. Styles, 1915, 32 pages, 9 figs. Obtainable from the Division of Publications, U. S. Department of Agriculture. Several of the drawings contained in the bulletin show the method of ventilating the sanitary privy.







U. S. Department Yearbook Separate 712, "Sewage Disposal on the Farm" by G. M. Warren, 1916, 27 pages, 10 figures. Obtainable from the Division of Publications, U. S. Department of Agriculture. Several drawings showing the proper method of ventilating different types of farm privies.

#### EXPERIMENT STATION BULLETINS:

Wisconsin, Madison, Wis.

Bulletin 164, "Dairy Barn Ventilation" 1908. Complete description (Illustration of the King System of Barn Ventilation)

Bulletin 266, "Barns for Wisconsin Dairy Farms" 1916. Complete description (illustrated) of the King System of Barn Ventilation.

Connecticut, Storrs, Conn.

Bulletin 53, "Dairy Barn Ventilation" 1908. The advantage of good light and ventilation are pointed out with a description of the King System of ventilation.

Iowa, Ames, Ia.

Bulletin 132, "Poultry House Construction" 1912. Plan of an A-shaped poultry house with ventilation shown.

North Carolina, Raleigh, N. C.

Bulletin 228, "Apple Storage Houses Air Cooled" 1914. Points out essentials of construction including ventilation (drawings).

North Dakota, Agricultural College, N. D.

Bulletin 101, "Potato Warehouse Plans" 1912. Ventilation of warehouses taken up among other considerations.

Canada, Winnipeg, Can.

Manitoba Agricultural College Extension Bulletin 2 "Barn Ventilation" 1916. Showing the Rutherford and King Systems of barn ventilation (Illustrated)

Bulletin 13, "Barn Ventilation". A detailed discussion of barn ventilation.

Dominion Experiment Farm, Ottawa, Can.

Bulletin 78, "Ventilating Farm Buildings". A detailed discussion of barn ventilation.

Canada, Victoria, British Columbia.

British Department of Lands, Forest Service Bulletin. Farm Buildings, Series

Bulletin 1, "General Barns" 1915. Includes a discussion on barn ventilation

Bulletin 2, Farm Building Series, "Plans of Dairy Barns, Ice Houses, and Milk Houses", 1915. All of the barns shown are equipped with the Rutherford System of ventilating. Discussion of the System.

Bulletin 3, Farm Building Series, "Beef-cattle Barn Plans" 1915. All barns are shown equipped with Rutherford System of ventilation. Discussion of the system.

Bulletin 4, Farm Building Series, "Horse Barns" 1915. All barns are shown equipped with the Rutherford System of ventilation. Discussion of the system.

#### PARTIAL LIST OF PUBLISHED ARTICLES, 1915-1917

Hoard's Dairyman, Fort Atkinson, Wis.

Mar. 31, 1916 page 431. Suggestions for ventilation of a round milk room.

Built of brick, Stonington, Wis. (in answer to letter)

Nov. 26, 1915 page 571 "Size of Intake Flues". Discussion of relative sizes of intake and outlet flues in dairy barns.

Nov. 12, 1915 page 488 "Building an Exhaust Duct". Describes construction of duct (with drawing).

Nov. 5, 1915 page 459 "Barn Ventilation". Silage chute used as ventilator in barn. Ventilating old barn. (in answer to letter)

Wallace's Farmer, Des Moines, Iowa.







- Nov. 19, 1915. p. 6 "Ventilate your Corncrib". Suggestions of several methods of ventilation.
- Nov. 12, 1915. "Ventilation of Stables and Hog Pens". Editorial telling why ventilation is necessary and describing the principles of the King and the Rutherford Systems of ventilation.
- Nov. 5, 1915, p. 4, "Ventilation in the Farmhouse". Editorials several suggestions as to ventilation in the home.
- Farm Engineering, Chicago, Illinois.
- Feb. 1917, p. 14 "Ventilation in Barns". Scientific article, giving formulas re. air requirements for animals. Describes Rutherford and King Systems of ventilation.
- Feb. 1916, p. 12, "Ventilation of Stables". Gives figures of F. H. King, on air requirements for different stock.
- Feb. 1916, p. 24, "Sanitary Engineering - Proper Ventilation". Air requirements for farm animals with discussion of principles of barn ventilation.
- County Gentlemen, Philadelphia, Pennsylvania.
- March 4, 1916, "Fresh Air for Farm Animals". Describes King and Rutherford Systems of ventilation with drawings. Tables of air requirement and flue areas.
- Feb. 12, 1916. "Ventilating Stored Grain". Several suggestions for corn crib ventilation with drawing of one method.
- Ohio Farmer, Cleveland, Ohio.
- January 1, 1916, p. 13. "Poultry-house Ventilation". Method of ventilating poultry house 7 x 24. Answer to letter.
- Nebraska Farmer, Lincoln, Nebraska.
- Nov. 17, 1915, p. 1121. "Another Ventilator". Describes cheap ventilation for corn crib.
- Farm, Stock and Home, Minneapolis, Minnesota.
- Dec. 15, 1915, p. 746, "Pure Air for the Stock". Discussion of barn ventilation with drawings.
- American Agriculturist, Springfield, Massachusetts.
- Jan. 1916, p. 8. "Simple Window Ventilation." Stable window ventilator with drawing.

#### MANUFACTURERS OF VENTILATORS AND CUPOLAS.

- Anderson Mfg. Co., Des Moines, Iowa.
- Butler Mfg. Co., Kansas City, Missouri.
- Drew Carries Co., Waterlow, Wisconsin.
- Freeland Sons Co., Sturgis, Michigan
- Freeland Steel Tank Co., Portage, Wisconsin.
- Glor Bros. & Willis Mfg. Co., Attica, New York.
- Hawkeye Pump Co., Fairfield, Iowa.
- Hudson and Thurber Co., Minneapolis, Minnesota.
- Ideal Barn Equipment Co., Burnett, Wisconsin.
- James Mfg. Co., Fort Atkinson, Wisconsin.
- King Ventilating Co., Owatonna, Minnesota.
- C. A. Libbey Co., Oshkosh, Wisconsin.
- Louden Machinery Co., Fairfield, Louisiana.
- Mitchell Mfg Co., Milwaukee, Wisconsin.
- Mayer Mfg. Co., Montevideo, Minnesota.
- Nebraska & Iowa Steel Tank Co., Omaha, Nebraska.







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FENCES

There are four main types of fence in use in this country - wire, wooden, hedge and stone - but there are many modifications of these types. Present day conditions, with high-priced land, scarcity of timber, and high wages of farm labor, have made it impracticable in most localities for the farmer to construct any but wire fence.

A farm fence should combine the two qualities of service and economy. The fence that is erected at a low initial cost is not necessarily economical, for it may be short lived, which may make it very expensive.

The best kind of wire to use depends upon the purpose for which the fence is used. On a farm where mixed types of livestock are kept, a general purpose woven wire fabric is needed. If only horses and cattle are to be pastured, a coarser and less expensive woven wire fence can be used. Barbed wire fences, sufficient to turn cattle, can be much more cheaply built than woven wire fences. Although livestock are occasionally injured by barbed wire fences this type of fence, because of its cheapness, is to be preferred for pastures where only cattle or horses are kept.

The cost of a good general-purpose farm fence constructed from durable materials will be as follows:

| First Cost:                                                                                                                  | Per rod. |
|------------------------------------------------------------------------------------------------------------------------------|----------|
| Line posts; red cedar, hedge, locust, cement, or steel<br>(1 rod apart) - - - - -                                            | \$0.28   |
| Ends and braces; cedar, hedge, locust, cement or steel<br>(every 40 rods) - - - - -                                          | .125     |
| Woven wire; 10 strands, 47 inches high, stays 12 inches<br>apart, all No. 9 - - - - -                                        | .40      |
| Barbed wire; 1 strand placed 4 inches above top of the<br>woven wire - - - - -                                               | .035     |
| Staples - - - - -                                                                                                            | .005     |
| Labor cost of construction - - - - -                                                                                         | .09      |
| Total - - - - -                                                                                                              | \$ .935  |
| <hr/>                                                                                                                        |          |
| Annual cost of upkeep:                                                                                                       |          |
| Repairs, including the cost of keeping the fence row clean -                                                                 | .024     |
| Interest at 5 per cent on average investment (\$0.4675) - - -                                                                | .023     |
| Depreciation, estimating that the life of the fence is<br>22 years - - - - -                                                 | .043     |
| Total - - - - -                                                                                                              | .090     |
| Interest on the land occupied at the rate of 5 per cent per<br>year; 108.6 square feet per rod, valued at \$125 per acre - - | .155     |
| Total annual cost - - - - -                                                                                                  | \$ .245  |







The cost of woven wire is based upon its weight, and a reduction in cost may be obtained by using a style of fencing that has the wires spaced only as close together as is needed to meet the requirements. It is false economy to reduce the first cost of the fence by using a light grade of wire because to a great extent the durability of the fence depends upon the size of the wires in its make-up.

Relative amount of service given by different weights  
of woven-wire.

| Size of wire                | Years | Size of wire                | Years |
|-----------------------------|-------|-----------------------------|-------|
| No. 9 throughout            | 21    | No. 9 top and bottom, No.11 |       |
| No. 7 top, No.9 bottom,     |       | laterals, No. 12 stays      | 18    |
| laterals and stays No. 11   |       | No.10 top and bottom, No.11 |       |
| or No. 12                   | 20    | laterals and stays          | 17    |
| No. 9 top and bottom, No.10 |       | No.11 top and bottom, No.12 |       |
| laterals and stays          | 19    | laterals and stays          | 15    |
| No. 9 top and bottom, No.11 |       | No.12 top and bottom, No.14 |       |
| laterals and stays          | 18    | laterals and stays          | 13    |
| No. 9 top and bottom, No.12 |       |                             |       |
| laterals and stays          | 17    |                             |       |

Relative amount of service given by different widths  
of woven-wire.

| Height of fence, inches | 26   | 32 | 36   | 39   | 42   | 47   | 45   |
|-------------------------|------|----|------|------|------|------|------|
| Life of wire, years     | 17.2 | 17 | 18.3 | 18.8 | 19.9 | 18.9 | 21.7 |

Woven-wire fencing is made in numerous styles which are adapted to use under widely varying conditions, so it should not be difficult for the farmer to secure a style of fence, having only the requisite number of wires.

The tendency of iron and steel to rust or oxidize is a characteristic of the metal itself, independent of the presence of any impurities it may contain. All iron rusts in moist air unless it is protected by some sort of covering. There is, however, a very great variability in the way different irons rust. One will cover itself with a superficial layer of oxide, which will then act as a coating protecting the metal for many years, while another will pit so badly that the corrosion eats to the heart of the metal in a short time.

Experience has shown that wrought iron resists oxidation better than steel and this fact is probably explained as follows:







The process of manufacturing wrought iron involves the working of the iron by hand. By this means the impurities are oxidized and burnt off and the slag or cinder which always forms is worked into the metal, so that when it comes to be rolled not only are the impurities very evenly distributed throughout the mass but it possesses the structure of a bundle of fibres, each one of which is coated with a film of cinder, which protects it in a very large measure from rusting. Also it has a rough surface, which forms a more lasting bond with any protective coating than does the smooth surface of steel.

This method of preparing the iron so as to permit its being worked is a relatively slow process and has been replaced by the Bessemer and basic open hearth processes.

Space does not permit a description of these methods, however, both depend upon refluxing the steel with manganese. Steel has different degrees of hardness depending upon its carbon content. The carbon content of mild steel rarely runs above 0.1 to 0.2% while in hard steel the carbon may run as high as 1% or even higher. Steel also contains, besides silicon, small quantities of phosphorous and sulphur, both of which reduce the ductility and make the metal brittle.

Wire containing manganese will resist the passage of electricity through it to a greater extent than a wire that contains little or no manganese. In case the manganese were not dissolved or mixed with perfect uniformity throughout the iron, electrical currents might be generated in the wire when wet, which would lead to rapid corrosion and it is known that the more manganese there is present the shorter will be the life of the metal. This chemical decomposition by action of an electric current is called electrolysis and, for all practical purposes, can be likened to the oxidation or burning of some metal. If two pieces of iron of different chemical analysis - that is, containing different amounts of impurities - are dipped into a dilute solution of salt and the ends connected, it will be found that a difference of potential exists, an electrical current will flow, and, if continued, at least one of the iron pieces will be destroyed by oxidation.

Wire that is hung in the field is in just the condition to suffer from electrolysis if the metal is not perfectly homogeneous in structure; that is, if the manganese and other impurities are not perfectly distributed throughout the metal. Rain water dissolves small amounts of salts from the air, and therefore is a conductor of electricity. Water collected during a thunder shower is particularly rich in substances that conduct electricity, as the sparking of the lightning through moist air forms small quantities of nitric acid, and acids conduct electrical currents even better than salt solutions. Under the conditions cited all the elements are present to cause electrolysis.

This explanation is capable of accounting for the deep pitting observed in the corrosion of many wires, this pitting being characteristic of electrolytic action. It also accounts for the much more rapid corrosion of wire near the seashore, as the rain water in such locality contains more salt and thus this action is hastened.







Although the effects of electrolysis in a fence wire may be extremely small, it must be remembered that they are continually going on whenever the wire is wet. In almost all modern steel woven-wire fences some wires will be found to far outlast others, independent of the original weight of the galvanized covering which they carry. This unevenness of lasting quality is difficult to account for except by the theory of electrolytic action.

The bottom wires lying close to the ground, which are kept wet in summer by the growth of weeds and grass and in winter by melting snow are far more lasting than the wires farther removed from the ground. Furthermore, wires that are stapled to living trees will almost invariably be preserved to some extent in the immediate neighborhood of the point of contact. This is not because of a certain protection afforded by the growth about the wires but because the electrolytic action is diminished; since the wires are electrically neutral through frequent connection to the earth, or through frequent short circuits.

The quality of the steel should be such that it will resist corrosion even though it is to be covered with a protective coating of zinc. For it is extremely unlikely that any coating is sufficiently water-proof or sufficiently elastic not to develop numerous cracks and openings through which water can act and electrolysis begin. Once begun, the electrolytic action corrodes zinc even more rapidly than it does steel. This may explain the very rapid disappearance of the galvanized covering from some wires and its great tenacity on others.

The word "galvanizing" as used gives a wrong impression. It is possible to dissolve zinc in an acid and then by means of a galvanic current, to deposit it as a coating upon another metal like iron. It has been shown that this method will give the most adhesive coating of zinc upon iron that it is possible to obtain but it is too expensive for commercial use. The custom is to pass the wire, when manufactured for fencing, after it has been cleaned with acid, through a molten bath of zinc, and then through asbestos wipers. The object of the wipers is to remove all excess of zinc and make the coating smooth.

A very much better covering and perhaps a more durable wire can be made by what is known as the double galvanizing process. The double process does not, as its name implies, mean that more than one coating of zinc is put on, but only that about twice as much zinc by weight is carried by the wire. In the double process the wire is drawn much more slowly through the zinc bath and does not pass through asbestos wipers, but is smoothed by passing through a shallow bed of slightly damp charcoal powder. Telegraph wire is usually treated by this method and is generally acknowledged to be more durable than fence wire, but it is worth noting at the same time that care is exercised in the manufacture of telegraph wire to keep the manganese low, because the presence of this element increases the electrical resistance of the wire.







People have come to realize that the amount of galvanizing carried by the wire greatly affects its life and demand fencing with a heavy coating of it. The relative amount of galvanizing or spelter on a wire may be determined by testing the wire in a solution of copper sulphate.

The common test applied to determine the relative amount of spelter carried by a woven-wire fabric is as follows: A saturated solution of copper sulphate is made by dissolving 36 parts of copper sulphate to 100 parts of water by weight. Not less than a quart of the solution should be used in the test, and to make a quart of the saturated solution requires approximately  $11\frac{1}{2}$  ounces of copper sulphate, or, as it is commonly called, blue vitriol. Slightly more than this amount should be used, however, as there should be a small excess of the copper sulphate. This may be either left in the solution or the solution may be strained off from it. The wire to be tested is immersed in the prepared solution, which should be at a temperature of 60 to 70° F., and left for one minute, at the end of which time it should be removed and wiped thoroughly dry. This operation should be repeated until the wire shows a deposit of metallic copper. The copper will not be deposited on the wire until the galvanizing is removed and a well-galvanized wire should stand at least three immersions in the copper sulphate solution without showing copper deposits on it. Some specially galvanized wire will withstand four immersions without showing copper. This wire is known as four-minute wire, and may be had at a slight advance in price. When common commercial copper sulphate is used in performing the test, there is a very slight excess of acid present in the copper sulphate solution which, if not neutralized, may cause the solution to act more strongly on the wire than it should. The acidity may be neutralized by adding a small amount of copper oxide; 2 ounces to a quart of solution should be sufficient. On account of the nonsolubility of the copper oxide it must be added a long time, at least a month, prior to the time the solution is to be used.

#### Posts.

The cheapest post to use will vary with the conditions found in the locality where the fence is to be built and it is not advisable to construct a permanent wire fence on posts that will not last as long as the wire. There are 3 kinds of posts in use for farm fences - wood, iron and concrete.

Wood posts are generally used in timbered sections, due to their cheapness compared with iron and concrete. Some wood is very durable, lasting from 8 to 20 years without preservative treatment, while certain kinds will last less than 8 years and should not be used without being given preservative treatment.

#### Average Life of Untreated Wood Posts

|                     |                    |                 |
|---------------------|--------------------|-----------------|
| Osage Orange.....30 | Chestnut.....15    | Hemlock.....9   |
| Locust .....24      | White Cedar.....14 | Sassafras.....9 |
| Red Cedar.....20    | Walnut.....12      | Elm.....9       |
| Mulberry.....17     | Pine.....11        | Ash.....9       |
| Catalpa.....16      | Tamarack.....10    | Red Oak.....7   |
| Bur Oak.....15      | White Oak.....11   | Willow.....6    |
|                     | Cherry.....10      |                 |







It is estimated that concrete posts will last 48 years, stone 36, and steel 30, but these estimates are guesses at best as the life of these types of posts depends upon many variables.

The most effective preservative for wood fence posts is creosote. The method applicable to use on the farm is described in Farmers' Bulletin 744, "Preservative Treatment of Farm Timbers." A copy of this bulletin can be had by applying to the Office of Publications, Department of Agriculture, Washington, D. C.

Various types of steel fence posts are available including L., T., tubular and U shaped. The greatest appeal to users of steel posts is the fact that they are so easily handled. When conditions are right for driving, 2 men should be able to drive 500 posts in a day. Other advantages claimed are, that they are not heaved by frost as are the more bulky ones and that they prolong the life of the fence and form a protection to stock in that currents of electricity carried by the fence during electric storms are grounded. Steel posts are criticised because they are bent by heavy stock rubbing against them but this defect can be avoided to a great extent by using a heavier post and stretching the wires tighter.

The concrete post appeals to the fence builder because of its supposed durability. To secure a durable concrete post it must be carefully made. The method of making such posts is described in Information Series No. 58, "Concrete Fence Posts," a copy of which can be secured from the Division of Agricultural Engineering, Bureau of Public Roads, Department of Agriculture, Washington, D. C.

To get the maximum of service out of a fence it is absolutely necessary that it should be well built. The corner posts must be placed solidly in the ground in such a manner that they can not be heaved by frost or drawn loose by the pull of the fence. The fabric should be strung tightly to the end posts, but it ought not to be tightly stapled to the line posts. It should be fastened to line posts in such manner that the wires may move in a horizontal direction to take care of the contraction and expansion due to changes in temperature, and to distribute the force of a blow along the fence line so that the strain will not come entirely on any one or two posts or any one point of the wire. A barbed wire should be placed a short distance above the top of the woven wire to prevent cattle and horses from crowding it down when reaching over or rubbing against the fence.







Amount of fence that two men can build in a day.

| Kind of fence            | Day's Work |                    |          |          |
|--------------------------|------------|--------------------|----------|----------|
|                          | : 12 feet  | : 13 to            | : 17 to  | : 25 to  |
|                          | : or       | : 16 $\frac{1}{2}$ | : 24     | : 37     |
|                          | : less *   | : feet *           | : feet * | : feet * |
| Barbed wire:             | :          | :                  | :        | :        |
| 2 strands -              | : Rods     | : Rods             | : Rods   | : Rods   |
| Posts driven .....       | : ----     | : 89.5             | : 95.0   | : 166.9  |
| Posts set .....          | : 58.7     | : 71.5             | : 75.0   | : 121.5  |
| 3 strands -              | :          | :                  | :        | :        |
| Posts driven .....       | : 64.0     | : 89.1             | : 116.4  | : 156.0  |
| Posts set .....          | : 43.7     | : 58.7             | : 68.3   | : 95.4   |
| 4 strands -              | :          | :                  | :        | :        |
| Posts driven .....       | : 76.6     | : 83.2             | : 92.4   | : 95.0   |
| Posts set .....          | : 39.3     | : 47.9             | : 50.6   | : 70.8   |
| 5 strands -              | :          | :                  | :        | :        |
| Posts driven .....       | : 52.2     | : 56.7             | : 70.9   | : 100.0  |
| Posts set .....          | : 25.3     | : 34.1             | : 38.7   | : 46.2   |
| 6 strands -              | :          | :                  | :        | :        |
| Posts driven .....       | : 29.5     | : 56.7             | : 67.5   | : ----   |
| Posts set ...            | : 19.4     | : 26.4             | : 32.0   | : 34.1   |
| Narrow woven wire with 2 | :          | :                  | :        | :        |
| or more barbed wires:    | :          | :                  | :        | :        |
| Posts driven .....       | : 48.7     | : 53.0             | : 74.1   | : 89.8   |
| Posts set .....          | : 26.3     | : 33.0             | : 37.9   | : 47.1   |
| Wide woven wire with 1   | :          | :                  | :        | :        |
| barbed wire:             | :          | :                  | :        | :        |
| Posts driven .....       | : 50.9     | : 55.3             | : 77.2   | : 94.2   |
| Posts set .....          | : 27.2     | : 33.9             | : 39.9   | : 49.7   |
| Wide woven wire without  | :          | :                  | :        | :        |
| barbed wire:             | :          | :                  | :        | :        |
| Posts driven .....       | : 61.3     | : 65.4             | : 80.2   | : 108.5  |
| Posts set .....          | : 30.6     | : 39.0             | : 45.8   | : 56.7   |

\* Distance apart of posts.

The attached drawing, Serial No. 2119, shows the method of setting posts at corners, in depressions and illustrates other pertinent suggestions.

Blueprints for the following drawings can be had by writing to the Division of Agricultural Engineering; Bureau of Public Roads, Department of Agriculture, Washington, D. C.

1471, Gate, 4 x 12 ft. Suitable for pasture lots, horizontal wood rails.

1449, Movable Scales Fence.

1450, Creep. To be used in corner of hog lots.

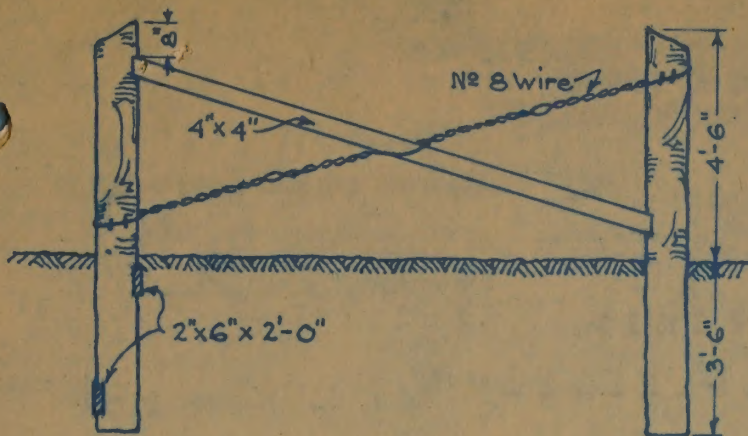
1625, Details of Flood Gate.

1951, Highway Cattle Guard.

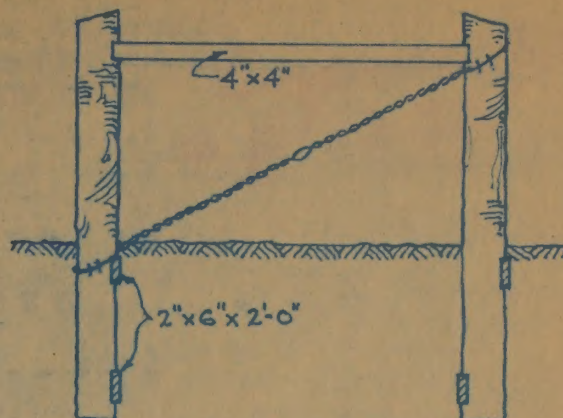




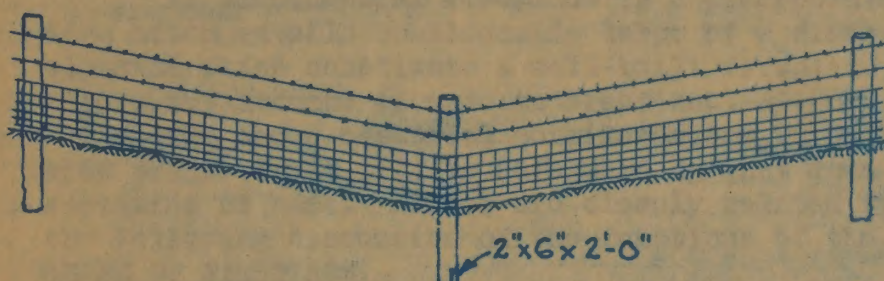




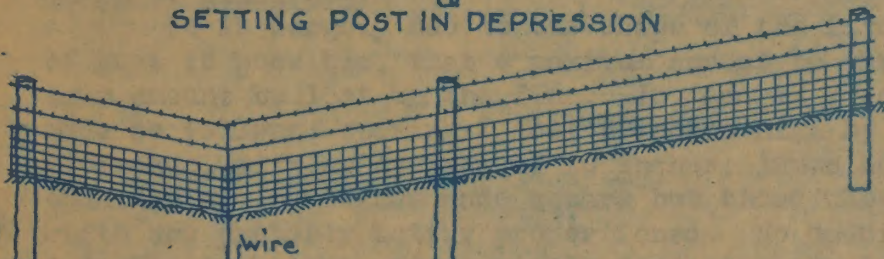
METHOD OF BRACING CORNER POSTS



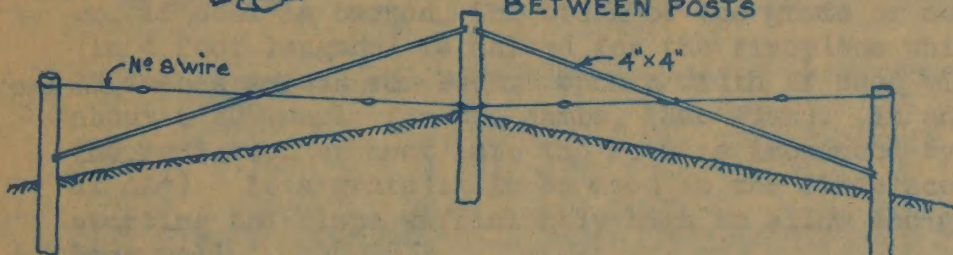
A GOOD CORNER POST BRACE



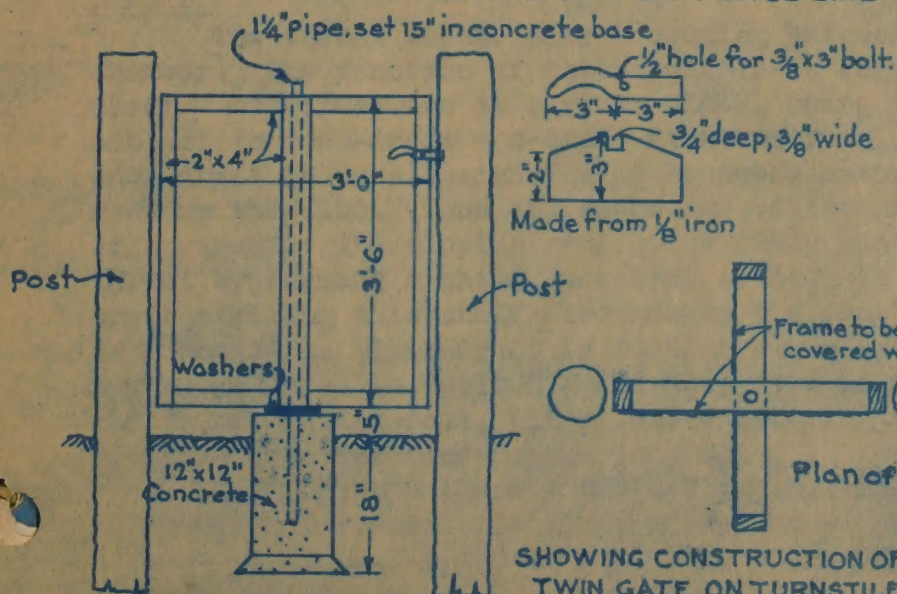
SETTING POST IN DEPRESSION



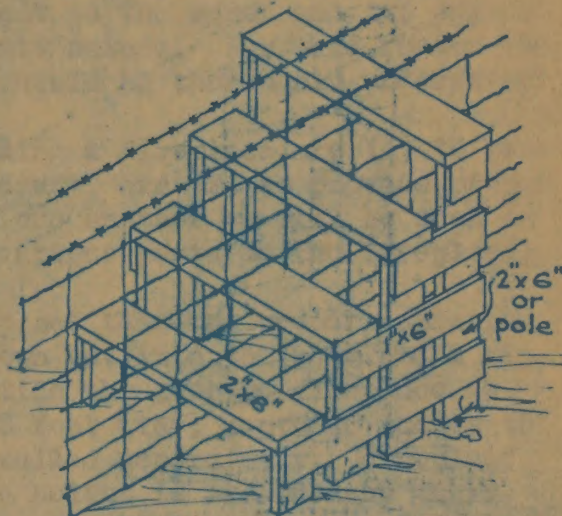
ANCHORING FENCE IN DEPRESSION BETWEEN POSTS



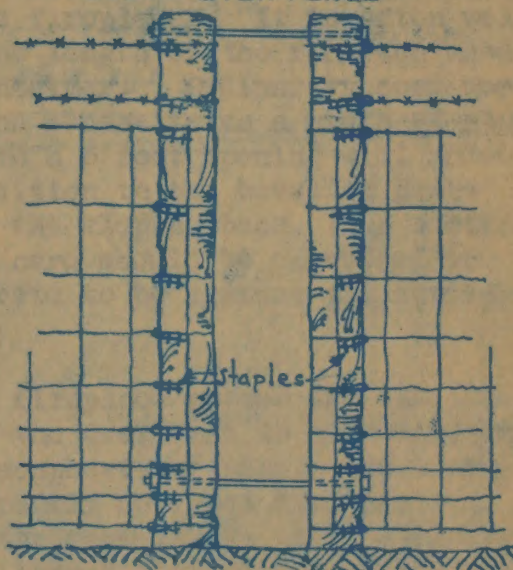
METHOD OF BRACING ON RIDGE, OR ON FENCE LINE



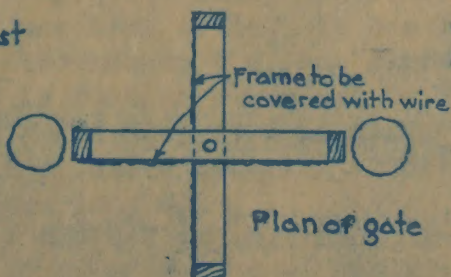
SHOWING CONSTRUCTION OF TWIN GATE ON TURNSTILE



STEPS OVER FENCE



SHOWING SPREAD POST METHOD OF PASSAGeway THROUGH FENCE AND METHOD OF FASTENING WIRES



Plan of gate

|                                |         |                          |  |
|--------------------------------|---------|--------------------------|--|
| U.S. DEPARTMENT OF AGRICULTURE |         | BUREAU OF PUBLIC ROADS   |  |
| DIVISION OF                    |         | AGRICULTURAL ENGINEERING |  |
| FENCE DETAILS                  |         |                          |  |
| Scale                          | CHECKED | SHEET ① OF ① SHEETS      |  |
| Drawn by                       |         | SUBJECT NO. SERIAL NO.   |  |
| Traced by N.B.                 |         | 698 2119                 |  |
| APPROVED                       |         |                          |  |

To accompany Information Series "28 revised.







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING.

*Superseded*  
*7. B 1230*  
August, 1918.

Information Series No. 29.

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FIREPLACES  
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INTRODUCTION.

An unsuccessful fireplace is a disappointment to the owner and its correction often entails considerable labor of a difficult nature. For this reason the elements which constitute a well-built fireplace should be thoroughly understood before any attempt is made to erect one.

The three essential considerations in building a fireplace are (1) to provide proper draft, (2) to safeguard against down-draft, and (3) to provide proper radiation of heat. These are closely related to one another as will be seen in the following discussion of the functions of the various parts of the fireplace:  
SHAPE OF FIREPLACE.

It is largely due to the shape of the fireplace that the proper radiation of heat is possible, that a maximum amount be thrown out into the room and a minimum amount be lost up the flue. In general practice the average fireplace is made as follows: opening 2 feet 6 inches high by 3 feet wide; depth 15 inches to 24 inches, with an average of 20 inches; jambs bevelled accordingly. Fireplace openings are sometimes made square but those whose height is exceeded by their width are probably better proportioned. No opening should be more than 3 feet 6 inches in height and then only for extremely large fireplaces. It is often well to consider the width across the back in terms of the length of the firewood used, or, if coal is burned, the width of the grate or container. Ordinarily cord wood (in 4 foot lengths) is halved for the fireplace which necessitates a width of about 28 inches across the back. Such a width if used with a 3 foot opening will allow about a 20° angle for the jambs, (See Plan). In addition to the bevelled jambs the radiation of heat into the room is increased by the sloping back. (See section at AA<sup>1</sup>) If a grate is to be used in the fireplace care should be exercised in starting the slope sufficiently high to allow the grate to be against the straight back wall.

THROAT.

The throat is the narrow opening between the fireplace proper and the smoke chamber. The function of the throat is to regulate the draft and to prevent down-draft. All flues are at certain times, owing to atmospheric or local conditions, subject to down-draft - a draft down the flue. In poorly designed fireplaces down-draft is usually manifested by smoke entering the room rather than being carried up the flue. Thus the advantage of the narrow throat (not exceeding 4 inches) is apparent. The sloping back (previously mentioned) makes possible the narrow throat by forming a shelf just back of it. It has been demonstrated that any down-draft striking this shelf rebounds up the flue carrying with it the smoke and gas from the fire. Down-draft is further combatted by a damper in the throat which may be adjusted as desired. The damper is used also in regulating the up-draft and in preventing soot, flies, etc., entering the room in the summer when the draft is down the flue rather than up.

Iron chimney throats are now manufactured, in different sizes, by a number of commercial firms. The chief advantage of the metal throat lies in the saving







of time and labor of the mason; in providing smooth surfaces - indispensable to maximum draft, and difficult in masonry; and in acting as a lintel to support the masonry above.

#### SMOKE CHAMBER.

The smoke chamber requires care in construction otherwise "smoking" may possibly result. The sides should be drawn in, at first, toward the center of the chimney (see elevation drawing) to insure a uniform draft throughout the width of the fireplace; square corners and angles tending to interrupt upward draft should be avoided; and the area should be decreased gradually until it is connected with the flue. In common practice the smoke chamber is finished off with a cement coat on the masonry. This, of course, is open to the objection that any settlement in the masonry will be extended to the cement coat. For this reason iron, terra-cotta, or reinforced cement smoke chambers are frequently installed.

#### FLUE.

The cross-section of the flue bears a direct relation to the area of the fireplace opening. From one-tenth to one-twelfth of the opening area is found to be adequate for the flue area. Hence a fireplace opening 3 feet wide by 2 feet 6 inches high, having  $7\frac{1}{2}$  square feet area, requires a flue whose cross-section ranges from 90 square inches to 108 square inches. The nearest commercial size of flue within this range is 8 inches by 12 inches - practically one-eleventh of the area of the opening.

The sketches show an inside fireplace and flue. If the chimney is built in an outside wall it would be well to leave a two-inch air space between the rough brick and the firebrick lining of the fireplace. All the stuffing should be kept away at least two inches from the brickwork. Spaces thus left should be filled in at the floor lines with mineral wool or other non-combustible material in order to act as vermin and fire stops.

#### CAUSES OF SMOKY FIREPLACES AND SUGGESTED REMEDIES.

The causes of smoky fireplaces are numerous and frequently difficult to detect. For this reason it may be well to enumerate some of the more common causes why fireplaces smoke and also to point out a possible remedy.

Obstructions in the flue caused by birds, brick, mortar, etc., are a common cause for smoky fireplaces. If a weight lowered from the top of the flue does not remove the obstruction, its location should be determined by the length of the cord and the flue opened at that point, or, if a bend in the flue prevents the weight from descending, the flue should be opened just below the bend and the obstruction reached from this position.

The size of the flue should be examined. Smoking will often result if it is either too large or too small, as in the former case the draft is too sluggish, and in the latter case free passage of smoke and gases is impossible. It should be seen the cross section of the flue is from one-tenth to one-twelfth of the area of the opening. If the flue is found to be too small, the fireplace opening may readily be decreased, to establish the proper relation. If the flue is too large the chimney height may be increased or a flue of smaller dimensions lowered into the original one.

Sometimes the throat is too small to admit the smoke freely. The relation of the throat to the fireplace opening should be determined as previously outlined and the throat increased or the opening decreased accordingly. A throat too large admits a certain amount of unheated air which tends to cool the flue and retard the upward movement. In such a case the area of the throat may be decreased.







Owing to a sharp bend or angle in the flue, especially if it is near the throat, smoke is sometimes rebounded into the room. Such a defect is difficult to remedy and frequently necessitates rebuilding.

If the chimney is too short the difference in weight of the exterior air column and the column of smoke is insufficient to produce the proper upward movement. This may be overcome by increasing the height of the chimney or decreasing the size of the fireplace that a greater amount of unheated air will be excluded. The chimney should be at least 16 feet above the smoke chamber and a foot above the ridge of the roof for good results.

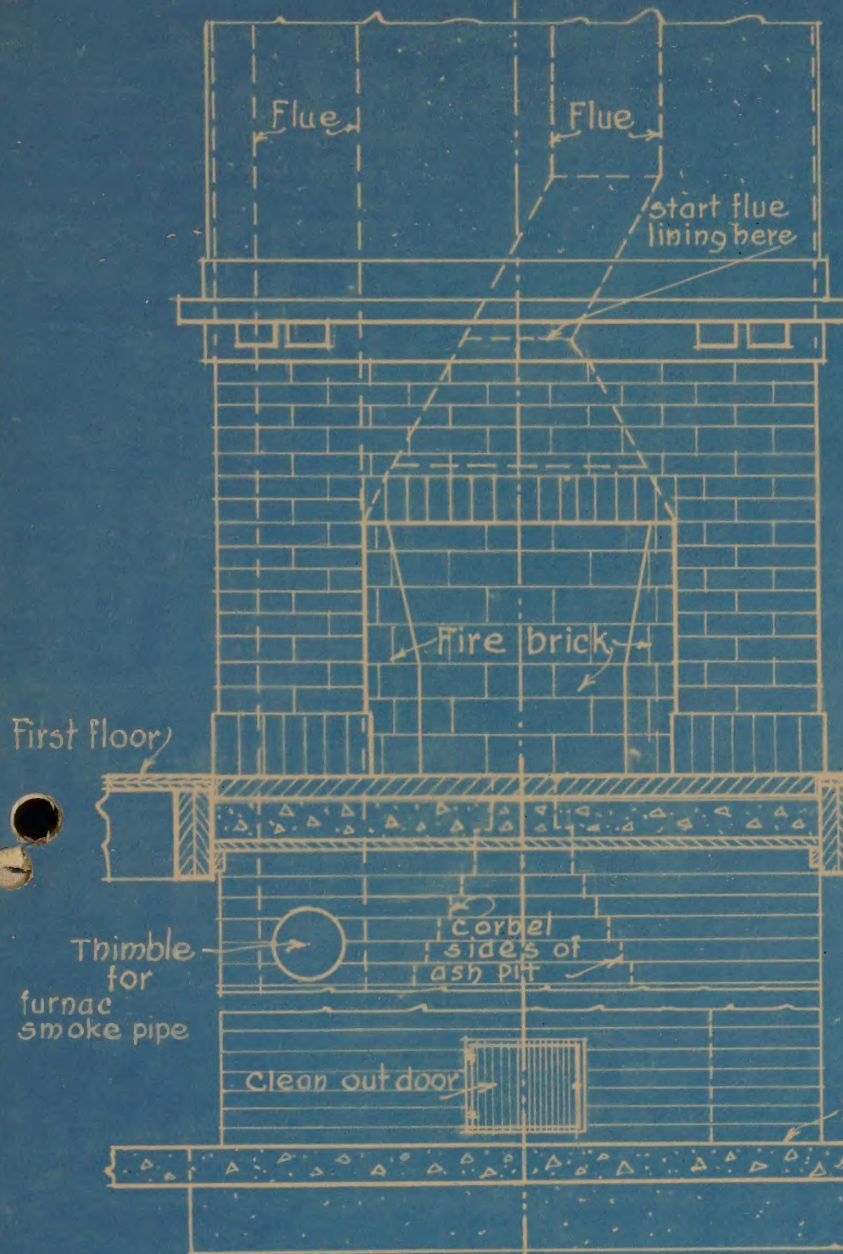
Owing to poor construction, or to settlement in the brickwork, the draft from one flue may enter another thus impairing its efficiency. This defect may be detected by building successive fires in the flues and noting from which the smoke comes. Such a case calls for rebuilding or closing the one flue by means of the damper while the other is in use.

Where the draft is interfered with by adjacent buildings, or other objects it is necessary to raise the chimney above the plane of influence.

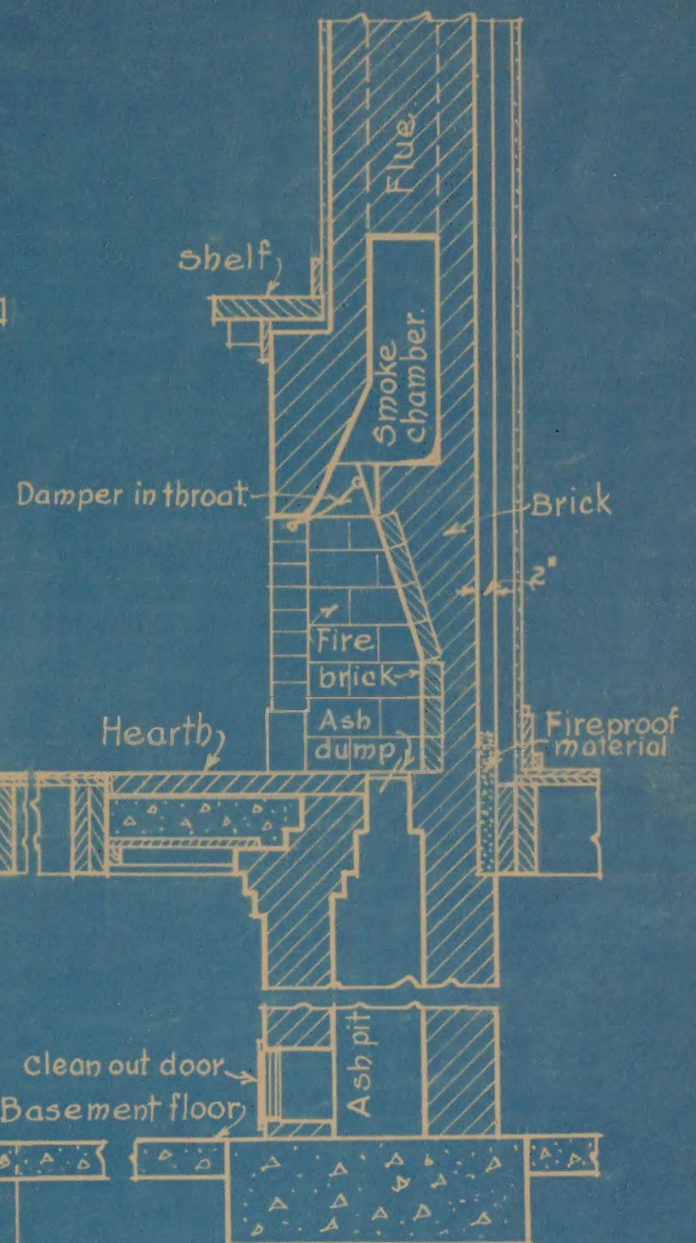




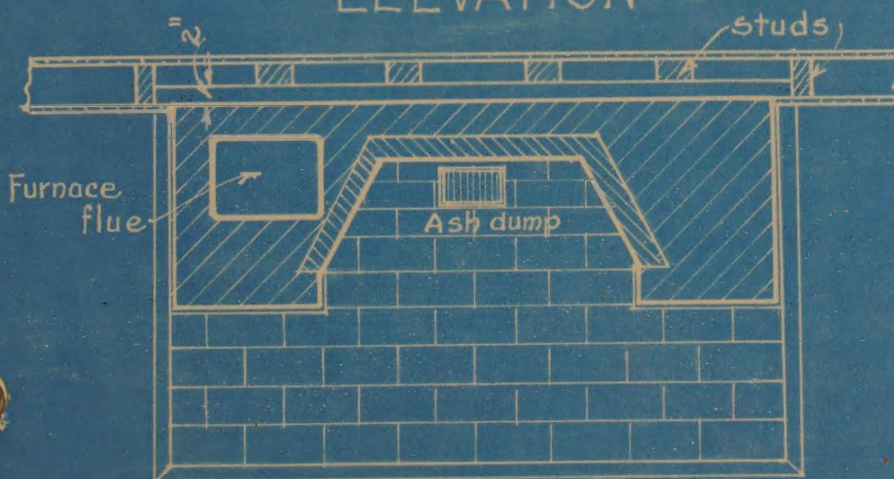




ELEVATION



SECTION



PLAN

DATE April 15, 1919. FILE 44.

|                                    |          |                     |            |
|------------------------------------|----------|---------------------|------------|
| U.S. Department of Agriculture     |          |                     |            |
| Office of                          |          |                     |            |
| PUBLIC ROADS AND RURAL ENGINEERING |          |                     |            |
| L. W. Page - Director              |          |                     |            |
| Division of                        |          |                     |            |
| RURAL ENGINEERING                  |          |                     |            |
| FIREPLACE                          |          |                     |            |
| Scale: 1/2" = 1'-0"                | CHECKED  | SHEET ① OF ① SHEETS |            |
| DESIGNED BY                        |          |                     |            |
| DRAWN BY K.                        |          |                     |            |
| TRACED BY K.                       |          |                     |            |
| APPROVED                           | E. B. M. | SUBJECT NO.         | SERIAL NO. |
|                                    |          | 620E                | 1097       |







U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

*Superseded  
by 7.B 1132*

INFORMATION SERIES - No. 30.

August, 1918.

FARMSTEAD PLANNING

DEPARTMENT OF AGRICULTURE PUBLICATIONS:

\*Farmers' Bulletin 185, "Beautifying Home Grounds," by L. C. Corbett, 1904, 24 pages, 8 figs. Price 5 cents. Bulletin deals with adornment of the home grounds by plantings of shrubbery, trees, etc. Several suggestive planting plans are given.

Farmers' Bulletin 228, "Forest Planting and Farm Management," by George L. Clothier, 1909, 21 pages, 3 figs. Bulletin discusses features of forest planting about the farmstead. Several farm layouts and one farmstead plan given. This bulletin is out of print but may be found in many libraries.

Farmers' Bulletin 788, "The Windbreak as a Farm Asset," by Carlos G. Bates, 1917, 15 pages, 8 figs. Obtainable from the Division of Publications, U.S. Department of Agriculture. The following phases are discussed: protection afforded by the windbreak: effects on the yield of crops; where and what to plant; ground space necessary; and direct returns from planting.

Planning a Farmstead. 1916, 15 pages, 3 figs. A manuscript article discussing the general principles of farmstead planning and dealing with a typical case for middle western conditions. Obtainable from the Division of Rural Engineering, Bureau of Public Roads, Washington, D. C.

STATE PUBLICATIONS

North Dakota Agricultural Experiment Station, Agricultural College, North Dakota. Circular 10, "The North Dakota Farmstead, Its Arrangement and Adornment," by H. O. Werner, 1916, 59 pages, 47 figs. The bulletin is devoted largely to horticulture, page 33, Location of farmstead, arrangement of farm buildings, Pages 34-48 deals with various phases of farmstead planning. Two farmstead plans shown with suggested planting plan.

Iowa State College of Agriculture, Ames, Iowa. "Model Farmstead," by Department of Horticulture and Forestry and the Department of Agricultural Engineering. Photograph of a farmstead model prepared at the college. Also plan drawing of farmstead and dwelling house. Suggestions for location and arrangement of farm buildings and for adorning the farmstead.

Iowa Agricultural Experiment Station Bulletin 126, "Planning and Adorning the Farmstead," by A. T. Erwin, 1912, 48 pages, 15 figs. Pages 30-41, "Planning the Farm in Relation to the Farmstead," by J. B. Davidson. Bulletin devoted to farmstead planning with suggestions for planting the home grounds.

University of Nebraska, Department of Agricultural Engineering, Lincoln, Nebraska. "The Nebraska Farmstead No. 1" Farmstead plan (drawing with discussion). Also general rules to be considered.

Minnesota Farmers' Institutes and Agricultural Extension Division, University Farm, St. Paul, Minn.

Minnesota Farmers' Institute Annual No. 22, 1909. Pages 23-29, "The Farmstead" by A. D. Wilson. General treatment of the subject. Four farmstead plans, (One for each possible location with regard to the highway) and one farm layout given.

Minnesota Farmers' Institute Annual No. 25, 1912, Page 115, "Planning the Farm," by A. D. Wilson. Several figures with discussion of the field arrangement of the farm with respect to location of the farmstead.

Minnesota Farmers' Institute Annual No. 27, 1914. Page 56, "The Farmstead,"

\*Obtainable from Supt. of Documents, Government Printing Office, Washington, D.C.

Stamps not accepted.







by A. D. Wilson. Four farmstead plans illustrated and discussed. Minnesota Farmers' Institute Annual No. 27, 1914, page 63. "Windbreaks and Woodlots," by E. G. Cheyney, A Farmstead plan shown with diagram of the proper way to plant the windbreak and wood lot. Page, 63.

#### PARTIAL LIST OF PUBLISHED ARTICLES.

Transactions of the American Society of Agricultural Engineers, Vol. No. 2, Dec. 1916. H. C. Ramsower, Sec'y Ohio State Agricultural College, Columbus, Ohio. Page 35.

"The Arrangement of the Farmstead" by L. W. Chase. Page 35. Various phases of farmstead planning discussed. 10 figures including two farmstead layout plans.

Country Gentleman, Philadelphia, Pa.

Jan. 8, 1916, Page 17 - "A Farmstead Plan." Illustrated article of a farmstead plan (north of the highway) Hollow square arrangement. (Reply to request from Montana).

April 29, 1916, page 4. "Farmstead Windbreaks." Illustrated article showing four possible arrangements of windbreaks to meet the orientation of the farmstead. Detailed discussion of the windbreaks.

Oct. 7, 1916, page 7, "How to arrange your buildings." Farmstead plan north of highway showing arrangement of the building shown.

The Farmers' Review, Chicago, Ill.

Aug. 28, 1915, page 5. "Arranging Farm Buildings." Arrangement of 320 acre general farm (showing farm layout and building arrangement.) Farm North of highway. (Reply to letter).

The Farmers' Guide, Huntington, Ind.

Feb. 19, 1916, page 38. "Rearranging a Rundown Farm." Farmstead plan for a 240 acre stock farm. Farm located north of the highway. (Reply to letter)

Farm and Home, Springfield, Mass.

Apr. 1, 1916, page 2, "Trees about the Farmstead." Illustrated article suggestive of the proper planting of trees about the farmstead. (Reply to letter.)

The Dakota Farmer, Aberdeen, South Dakota.

March 1, 1916, page 293, "Planning and Planting to Advantage." Suggestions for planting shrubbery and trees about the farmstead. Drawing showing proper location of plantings.

Heards' Dairyman, Ft. Atkinson, Wis.

Dec. 3, 1915, page 1, "Location of the Farmstead." General discussion of the factors to be considered in farmstead planning.

May 26, 1916, page 733, "Before Building." Article considers the farm building arrangement, of which a plan drawing is shown. Farm is north of the highway.

Sept. 8, 1916, page 206, "Location of Farm Buildings." A discussion of the various things to be considered in planning the location of the farm buildings.

Progressive Farmer, Raleigh, N. C.

March 18, 1916, page 5, "Some suggestions for the Home-Maker". Plan shown of the grounds with suggestive plantings about the house. Shrubby indicated by name.

New England Homestead, Springfield, Mass.

Oct. 23, 1915, page 6. "Increasing Farm Attractiveness." Plan showing quadrangle system of arrangement of the farm buildings. Highway north of farm.







- BOOKS; The following books are suggested because of their bearing upon different phases of the subject.
- The Farmstead, By I. P. Roberts. The Macmillan Company, New York, Publishers, 1914.
- Farm Buildings, by Alfred Hopkins, R. M. McBride Company, New York, Publishers, 1916.
- Farm Buildings, by Herbert A. Shearer, F. J. Drake & Co., Chicago, Publishers, 1917.
- Farm Structures, by J. K. T. Ekblaw. The Macmillan Co., New York, Publishers, 1914.
- Agricultural Engineering, by J. B. Davidson, Webb Publishing Co., St. Paul, Publishers, 1916.
- Farm Buildings, by Breeders' Gazette, Breeders Gazette, Chicago, Publishers, 1916.
- Farm Buildings, by Byron David Halsted, Orange Judd Co., New York, Publishers, 1903.
- Equipment for the Farm and the Farmstead, by Harry C. Ramsower, Ginn & Co Publishers, New York, 1917.
- Farm Buildings for Landowners, Agents, and Tenants, by C.E. Curtis, Vinton and Company, Publishers, London, 1912.
- Farm Buildings and Their Appurtenances, by Thomas Winder, Pawson & Bradsford, Publishers, Sheffield, 1908.
- Farm Buildings, by John Cleaudius Loudon, J. Harding, Publishers, London, 1812.
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Void

U. S. DEPARTMENT OF AGRICULTURE.  
BUREAU OF PUBLIC ROADS.  
DIVISION OF RURAL ENGINEERING.

Information Series - No. 31

August 1918

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DAIRIES

U. S. DEPARTMENT OF AGRICULTURE PUBLICATIONS:

\*Circular 131, "Designs for Dairy Buildings," by Ed. H. Webster, 1908, 26 pages, 35 figs., price 5 cents. Bulletin deals with the details of construction and the general requirements of dairy barns.

Farmers' Bulletin 689, "A Plan for a Small Dairy House," by Ernest Kelly, and Karl E. Parks, 1915, 4 pages, 4 figs., obtainable from Division of Publications, U. S. Department of Agriculture. Bulletin discusses the requirements of a dairy house giving plan, elevation, and sectional views of a small dairy house.

\*Farmers' Bulletin 602, "Production of Clean Milk," by Dairy Division; 1914; 18 pages, 6 figs., Price 5 cents. Bulletin discusses influence of stable construction on the production of clean milk. Requirements of milk house.

\*Farmers' Bulletin 748, "A Simple Steam Sterilizer for Dairy Farm Utensils," by S. Henry Ayers and George B. Taylor, 1916, 11 pages, 8 figs., price 5 cents. Details of Construction and Cost of sterilizer (illustrations).

AGRICULTURAL EXPERIMENT STATION BULLETINS:

Wisconsin, Madison, Wisconsin.

Bulletin 266, Dairy Barn Construction, 1916.

This bulletin contains a discussion of the general requirements of and the more important factors to be considered in the construction of dairy barns under Wisconsin conditions.

Bulletin 185, Sanitary Cow Stalls, 1909.

Several types of home-made cow stalls are illustrated and described.

Bulletin 164, Ventilation of Dairy Barns, 1908.

In this bulletin descriptions and detailed plans are presented which are sufficient to enable farmers to install the essentials of the King system of barn ventilation.

Kentucky, Lexington, Kentucky.

Bulletin 179, Construction and Equipment of Dairy Barns, pp. 37 - 117. 1914.

This bulletin gives information to dairymen on the construction and equipment of dairy buildings.

New Jersey, New Brunswick, New Jersey.

Report 1913, pp 346-354 1913. Dairy barn at the New Jersey State College, N. J. A dairy barn designed to provide space for hay storage and stable room for 40 cows.

Illinois, Urbana, Illinois.

Bulletin 143, Construction of Round Dairy Barn. 1910.

Advantages of round dairy barns, with details of construction of barn 60 feet in diameter.

Circular No. 188. The Construction of the Dairy House. 1916.



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D A I R I E S

DEPARTMENT OF AGRICULTURE PUBLICATIONS:

\*Circular 131, "Designs for Dairy Buildings," by H. H. Webster, 1908, 32 pages, 35 figs., price 5 cents. Bulletin deals with the details of construction and the general requirements of dairy barns.

\*Farmers' Bulletin 689, "A Plan for a Small Dairy House," by Ernest Kelly, and Earl E. Burns, 1915, 4 pages, 4 figs., obtainable from Division of Publications, U. S. Department of Agriculture. Bulletin discusses the requirements of a dairy house giving plan, elevation, and sectional views of a small dairy house.

\*Farmers' Bulletin 602, "Production of Clean Milk," by Dairy Division, 1914; 16 pages, 8 figs., price 5 cents. Bulletin discusses influence of stable construction on the production of clean milk. Requirements of milk houses.

\*Farmers' Bulletin 748, "A Simple Steam Sterilizer for Dairy Farm Use," by S. Henry Ayers and George B. Taylor, 1915, 11 pages, 8 figs., price 5 cents. Details of construction and cost of sterilizer (illustrations).

AGRICULTURAL EXPERIMENT STATION BULLETINS:

Wisconsin, Madison, Wisconsin.

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Bulletin 185, Semistall Cow Stalls, 1909.

Several types of home-made cow stalls are illustrated and described.

Bulletin 164, Ventilation of Dairy Barns, 1908.

In this bulletin descriptions and detailed plans are presented which are sufficient to enable farmers to install the essentials of the King system of barn ventilation.

Kentucky, Lexington, Kentucky.

Bulletin 179, Construction and Equipment of Dairy Barns,

pp. 37 - 117, 1914.

This bulletin gives information to dairymen on the construction and equipment of dairy buildings.

New Jersey, New Brunswick, New Jersey.

Report 1915, pp 345-354, 1915. Dairy barn at the New Jersey State College, N. J. A dairy barn designed to provide space for hay storage and stable room for 40 cows.

Illinois, Urbana, Illinois.

Bulletin 145, Construction of Round Dairy Barn, 1910.

Advantages of round dairy barns, with details of construction of barn 60 feet in diameter.

Circular No. 188. The Construction of the Dairy House, 1916.



Discusses essentials of dairy house and gives three plans, namely: - Dairy House, Dairy House for Making Butter, and Dairy House for Bottling Milk. Canada, Victoria, British Columbia.

Farm Building Series, Bulletin 2. Plans for Dairy Barns, Ice Houses, and Milk Houses, 1915. (continued)

Obtainable from Supt. of Documents, Government Printing Office, Washington, D. C.  
Prices as noted. Stamps not accepted.

Plans and discussion of several dairy barns, also discussion of the Rutherford System of Ventilation.

PARTIAL LIST OF PUBLISHED ARTICLES 1915 - 17.

Hearde Dairyman, Fort Atkinson, Wisc.

Nov. 12, 1915. P. 484. New Features in a Modern Barn. Description of hollow tile barn 36' x 80' with photograph. Interior-modern fireproof construction.

Jan. 7, 1916. P. 790. Replanning a Small Barn. Method of adding basement to the barn and replanning it to accommodate additional stock. (Reply to letter.) Barn plan shown.

Jan. 14, 1916. P. 819. Clean Milk from Simple Equipment. Equipment of Frankfort, Ind. dairy described. Concrete octagonal milking barn, interior and exterior photographs. Management of herd. Delivery outfit, etc.

Jan. 21, 1916. P. 871. Concrete Barn Foundation. Drawing and discussion of barn wall with special provision against ground dampness of floors from walls.

Oct. 1, 1915. P. 280. Sanitary Dairy Barns. General discussion of sanitary equipment with plans and elevations.

May 26, 1916. P. 758. Wood Blocks for Stall Floors. Gives three types of mangers with drawings.

Dec. 8, 1916. P. 690. Form and Utility in Dairy Barns. One-story barn vs. two-story barn, the round barn; Comparison of cost of lumber in round and rectangular barns.

Ohio Farmer: Cleveland, Ohio.

Sept. 18, 1915. P. 8. Remodeling Dairy Barn. Single-row cow stable discussed with reference to floor measurements. (Reply to letter.)

Nov. 20, 1915, P. 8. Ministers Success at Dairying. Description and plan of round dairy barn.

Feb. 5, 1916, P. 10. Concrete Manger for Cows. Cross-section of concrete manger shown. Creosoted blocks used for bed. Measurements and outline given in drawing.

Country Gentleman. Philadelphia, Pa.

Nov. 6, 1915, P. 1698. Warm Concrete Floors. Discussion of Construction of concrete floor with special reference to dimensions, method of procedure (concrete work), giving construction of templates used in shaping gutter, manger, etc. Cost data on Plain Concrete Stall Floor and Cork Brick Stall Floor.

Nov. 20, 1915. P. 1756. Cow Stall and Manger. Drawing and discussion of cross-section of cow stall with floor of creosoted Yellow Pine blocks.



Diagrams essential of dairy house and gives three plans, namely: - Dairy House, Dairy House for Making Butter, and Dairy House for Bottling Milk. Canada, Victoria, British Columbia. Farm Building Series, Bulletin 2. Plans for Dairy Barns, Ice Houses, and Milk Houses, 1915. (continued)

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Sept. 25, 1915. P.1482. A Modern Barn for the Dairy Farm. Plan and cross-section of dairy barn. Materials and estimate for a 12-foot section of barn, also materials for two ends of a 36-foot barn.

May 6, 1916. P.972. Barn for 40 cows. Barn plan given with brief discussion.

June 10, 1916. P.1178. Germ-proof and Fire-proof Cow House.

Complete description of dairy barn 36 x 100, including construction, barn equipment, ventilating system, and cost data. Plan and elevations shown.

Farmers' Guide. Huntington, Ind.

Dec. 18, 1915. P.11. A Flyless Dairy. Method of combatting flies about the dairy barn.

Mch. 4, 1916. P. 4. A Remodeled Dairy Barn. Describes method with further recommendations for enlarging barn. Plans and elevations shown.

June 24, 1916. P. 22. Subscriber wishes to remodel his farm barns.- Is going into the dairy business. Shows present arrangement and suggestions for remodeling.

Rural New Yorker, New York.

Sept. 11, 1915. P. 1. Well Organized Milk Dairy. One-story barn, monitor roof, tile construction with cement interior, two tile siles. Materials and construction given with illustration of barn.

Jan. 1, 1916. P. 19. Plan for Cow Barn. Cow barn plan given, 40' x 70' for 30 cows, box stalls, etc. Stable construction given.

LIST OF PUBLISHED ARTICLES 1915-17 (Milk Houses).

Farmers' Guide, Huntington, Ind.

Oct. 23, 1915, P. 10. Plan for a Small Dairy House. Description (illustrated) of dairy house designed by U. S. Department of Agriculture, Dairy Division and published as Farmers' Bulletin 689. Plan drawing shows provision for milk room, wash room, boiler room, etc.

Mch. 10, 1917. P. 16. A Good Dairy House. Article discusses a few general principles that should be followed in building a dairy house. Illustration shows a concrete milk house.

Boards Dairyman, Ft. Atkinson, Wis.

Mch. 17, 1916. P. 329. A Dairy and Laundry House. House 14' x 24' x 9' to eaves, constructed of hollow-tile with concrete floor. Bill of materials with prices given.

Country Gentleman, Philadelphia, Pa.

Oct. 30, 1915. P. 1650. The Business of Dairying, - The Milk House. Article describes 12' x 18' dairy house intended to be suitable to the needs of the average farm. Details of construction given.

Farm Engineering, Chicago, Ill.

July, 1916. P. 3. Sanitary Milk Houses. Describes essentials of adequate milk house. Illustrated article.

Rural New Yorker, New York.

May 6, 1916. P. 730. Construction of Milk House. Plan of milk house shown 10' x 10', with discussion of arrangement and details of construction.

Iowa Homestead, Des Moines, Iowa.

Jan. 20, 1916. P. 25. A Concrete Milk House. Plan and section of milk house 12' x 16' x 8' high. Plan shows arrangement of apparatus.



Sept. 22, 1915. P. 1482. A Modern Barn for the Dairy Farm. Plan and cross-section of dairy barn. Materials and estimate for a 12-foot section of barn. Also materials for two ends of a 36-foot barn.

May 6, 1915. P. 972. Barn for 40 cows. Barn plan given with brief discussion.

June 10, 1915. P. 1170. Germ-proof and fire-proof Cow House. Complete description of dairy barn 36 x 100, including construction, barn equipment, ventilating system, and cost data. Plan and elevations shown.

Dec. 18, 1915. P. 11. A Flyless Dairy. Method of combating flies about the dairy barn.

Mich. 4, 1915. P. 4. A Remodeled Dairy Barn. Describes method with further recommendations for enlarging barn. Plans and elevations shown.

June 24, 1915. P. 22. Describes plans to remodel six farm barns. - Is going into the dairy business. Shows present arrangement and suggestions for remodeling.

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Oct. 22, 1915. P. 10. Plan for a Small Dairy House. Description of dairy house designed by U. S. Department of Agriculture, Dairy Division and published as Farmers' Bulletin 682. Plan showing shows provision for milk room, wash room, boiler room, etc.

Nov. 10, 1917. P. 16. A Good Dairy House. Article discusses a few general principles that should be followed in building a dairy house. Illustration shows a concrete milk house.

Nov. 17, 1915. P. 329. A Dairy and Laundry House. House 14' x 24' x 9' to eaves, constructed of hollow-tile with concrete floor. Bill of materials with prices given.

Oct. 30, 1915. P. 1580. The Business of Dairying. - The Milk House. Article describes 12' x 18' dairy house intended to be suitable to the needs of the average farm. Details of construction given.

July, 1915. P. 3. Sanitary Milk Houses. Describes essentials of adequate milk house. Illustrated article.

May 5, 1916. P. 730. Construction of Milk House. Plan of milk house shown 10' x 10', with discussion of arrangement and details of construction.

Jan. 20, 1916. P. 25. A Concrete Milk House. Plan and section of milk house 12' x 16' x 8' high. Plan shows arrangement of apparatus.



CREAMERIES

| <u>Plan No.</u> | <u>Capacity<br/>(pounds-butter)</u> | <u>System</u>   | <u>Natural Ice or Refrigeration</u> |
|-----------------|-------------------------------------|-----------------|-------------------------------------|
| G - 1           | 500 - 1000                          | Whole Milk      | Refrigeration Machine.              |
| G - 2           | 500 - 1000                          | Hand Separator  | Refrigeration Machine.              |
| G - 3           | 1000 - 2000                         | Whole Milk      | Natural Ice.                        |
| G - 4           | 1000 - 2000                         | Whole Milk      | Natural Ice.                        |
| G - 6           | 500 - 1000                          | Hand Separator. | Refrigeration Machine.              |

MISCELLANEOUS

| <u>Plan No.</u>  | <u>Description</u>                                  |
|------------------|-----------------------------------------------------|
| M - 2            | Cow stall -- wood floor                             |
| M - 3            | Iron cow stall details concrete floor               |
| M - 4            | Iron cow stall details, cork-brick floor            |
| M - 19           | Calf stanchion details.                             |
| Sub. No. 680 - B | Concrete farm sterilizer.                           |
| Ser. No. 452     |                                                     |
| M - 21           | Septic tank, 1600 gallon capacity for creamery use. |
| O - 1            | Mamure shed.                                        |

MANUFACTURERS OF DAIRY BARN EQUIPMENT.

|                             |                             |
|-----------------------------|-----------------------------|
| Badger Wire & Iron Works,   | Milwaukee, Wisconsin.       |
| Creswell Iron works,        | Philadelphia, Pennsylvania. |
| Fiske Iron Works,           | New York, N. Y.             |
| Hunt-Helm-Ferris & Co.,     | Harvard, Illinois.          |
| James Manufacturing Co.,    | Fort Atkinson, Wisconsin.   |
| Louden Machinery Co.,       | Fairfield, Iowa.            |
| Love Brothers,              | Aurora, Illinois.           |
| Mack Iron & Wire Works Co., | Sandusky, Ohio.             |
| Myers Mfg. Co.,             | Hamilton, Ohio.             |
| Mott Iron Works,            | New York, N. Y.             |
| J. E. Porter Co.,           | Ottawa, Illinois.           |
| Price-Evans Foundry Co.,    | Chattanooga, Tennessee.     |
| Schouler Cement Construct-  |                             |
| ion Company,                | Newark, New Jersey.         |
| Smith Wire & Iron Works,    | Chicago, Illinois.          |
| Wright Wire Co.,            | Worcester, Massachusetts.   |



CREAMERIES

| Plan No. | Capacity<br>(pounds-per hour) | System         | Natural Ice or Refrigeration |
|----------|-------------------------------|----------------|------------------------------|
| 6 - 1    | 500 - 1000                    | Whole Milk     | Refrigeration Machine.       |
| 6 - 2    | 500 - 1000                    | Hand Separator | Refrigeration Machine.       |
| 6 - 3    | 1000 - 2000                   | Whole Milk     | Natural Ice.                 |
| 6 - 4    | 1000 - 2000                   | Whole Milk     | Natural Ice.                 |
| 6 - 5    | 500 - 1000                    | Hand Separator | Refrigeration Machine.       |

MISCELLANEOUS

| Plan No.                         | Description                                        |
|----------------------------------|----------------------------------------------------|
| M - 1                            | Manure shed.                                       |
| M - 21                           | Septic tank, 1600 gallon capacity for cremery use. |
| Rev. No. 452<br>Sub. No. 680 - 3 | Concrete farm sterilizer.                          |
| M - 13                           | Calf attachment details.                           |
| M - 4                            | Floor                                              |
| M - 5                            | Iron cow stall details, cork-brick                 |
| M - 3                            | Iron cow stall details concrete floor              |
| M - 2                            | Cow stall -- wood floor                            |

MANUFACTURERS OF DAIRY BARN EQUIPMENT.

|                              |                             |
|------------------------------|-----------------------------|
| Wright Wire Co.,             | Worcester, Massachusetts.   |
| Smith Wire & Iron Works,     | Chicago, Illinois.          |
| Ion Company,                 | Newark, New Jersey.         |
| Scholar Cement Concrete-     | Chattanooga, Tennessee.     |
| Price-James Foundry Co.,     | Ottawa, Illinois.           |
| J. R. Porter Co.,            | New York, N. Y.             |
| Mott Iron Works,             | Hamilton, Ohio.             |
| Myers Mfg. Co.,              | Sandusky, Ohio.             |
| Black Iron & Wire Works Co., | Aurora, Illinois.           |
| Loe Brothers,                | Fairfield, Iowa.            |
| Louden Machinery Co.,        | Port Atkinson, Wisconsin.   |
| James Manufacturing Co.,     | Barvard, Illinois.          |
| Hunt-Helm-Ferris & Co.,      | New York, N. Y.             |
| Fiske Iron Works,            | Philadelphia, Pennsylvania. |
| Cruswell Iron Works,         | Milwaukee, Wisconsin.       |
| Badger Wire & Iron Works,    |                             |



UNITED STATES DEPARTMENT OF AGRICULTURE  
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING  
DIVISION OF RURAL ENGINEERING

Information Series No. 32 .....August, 1918.

\* P L A S T E R A N D P L A S T E R I N G.  
MATERIALS.

LIME.

Quicklime or caustic lime is the resulting lime left from the calcination of limestone. It is chemically known as calcium oxide. "Slaking" is the process of chemical combination of quicklime with water.

Air slaking is hydration by the absorption of moisture from the atmosphere. The best qualities of lime should completely slake in 48 hours, but there are some limes in which some of the particles will not slake with the bulk of the lime, but continue to absorb moisture, and finally, after a long period, they will slake or pop, and if on a wall or ceiling will cause a speck of plaster to fall off,. Such limes should not be used for plastering.

Lime is shipped either in barrels or in bulk. In dry climates it will keep for a long time in bulk, but in damp climates it soon slakes unless enclosed in barrels or other containers. In most of the eastern cities it is sold by the barrel weighing for Rockland, (Maine) lime 220 pounds net. When shipped in bulk it is generally sold by the bushel of 80 pounds, 2-1/2 bushels, or 200 pounds of lime being considered as equivalent to a barrel.

SAND.

Although the use of sand in mortar is principally to prevent shrinking and to reduce the quantity of lime required, it is also considered to have a valuable chemical function, causing the formation of a hard silicate of lime which permeates and strengthens the plaster.

Sand is obtained from banks or pits, from river beds, and from the seashore. Pit or bank sand, free from clay or earth material, is generally considered best for mortar, although excellent sand is often obtained from river beds. Sea sand contains alkaline salts which attract and retain moisture. Such sand should be washed in fresh water before used.

Both sea and river sand have more or less rounded grains to which lime or cement will not adhere as well as to sharp, angular grains. Both are extensively used for lack of better materials. All sand should be carefully screened before using, and for hard finish the sand should be passed through a sieve.

Dry sand weighs from 80 to 115 pounds per cubic foot. The average weight of damp (not wet) sand is about 96 pounds per cubic foot or 2,600 pounds per cubic yard. A one-horse load of sand contains about 22 cubic feet. Two horse loads vary from 1 1/4 to 2 cubic yards.

\* Compiled from the following sources; Building Construction and Superintendency, Part 1, F. E. Kidder, 1905; Architects' and Builders' Pocket Book, F. E. Kidder, 1912; Building Estimator's Reference Book, Frank R. Walker, 1917.







### WOODEN LATHS.

Wooden laths should be well seasoned, free from sap, bark, and dead knots. Bark on laths is quite sure to stain the plaster. White pine is generally considered as the best wood for laths, although spruce and hemlock laths are much used. Hard pine is not a good material, as it contains too much pitch.

The regular size of laths is  $\frac{1}{4}$  inch X  $1\frac{1}{2}$  inch X 48 inches long; the width and thickness vary somewhat in different mills, and there is a new lath on the market 32 inches long. Laths are sold by the 1,000 in bundles containing 100.

In lathing for plaster  $\frac{3}{8}$  of an inch space should be allowed between laths on ceilings and from  $\frac{1}{4}$  to  $\frac{5}{16}$  of an inch on walls. End joints should be broken at least every 18 inches. Laths should be wet before the plaster is applied to prevent the plaster drying too rapidly.

### HAIR AND FIBRE.

Hair, such as is used by plasterers, is obtained from the hides of cattle, and after being washed and dried is put up in paper bags, containing approximately one bushel of hair when beaten up. Each package is supposed to weigh from 7 to 8 pounds, but the weight often falls short.

Asbestos and manilla fibre are substitutes for hair; they are cleaner than hair, and are said to be less injured by lime.

It is much better to add the hair or fibre to the lime paste after it is cold and before mixing in the sand, as hot lime, and the steam caused by slaking, burn or rot the hair so as to greatly weaken it.

### PROPORTIONING OF MATERIALS.

An average barrel of lump lime will, when thoroughly slaked, yield 2.62 barrels of lime paste. It has been determined by experiments that the average sum of voids in sharp, clean, silicious bank or pit sand, taken from different locations and thoroughly screened, was .349 of its bulk. It was also shown that the best mortar is obtained by mixing with the sand such an amount of lime paste as will be from 45 to 50 per cent greater than the amount needed to fill the voids of the sand. This practically requires a proportion of one part lime paste to two of sand. This is the proportion usually specified on Government work.

The proportion of hair to lime should be for first-class work,  $1\frac{1}{2}$  bushels of hair to one barrel (200 pounds) of lime for the scratch coat, and  $\frac{1}{2}$  bushel of hair to one barrel of lime for the brown coat.

### MIXING MORTAR FOR PLASTERING.

The proper mixing of lime mortar is quite as important as the selection of the proper materials.

The lime should be thoroughly slaked in a tight box, or, if the lime is not pure, and a residue is left after slaking, it should be run off through a wire sieve into another box and allowed to stand from 24 hours to seven days.

After the lime has been slaked the required length of time the hair should be beaten up and thoroughly incorporated with the lime paste with a hoe, the proper amount of sand then added, and the mixture thrown into a pile.







After the mortar has stood in the pile not less than seven days it should be wet up with water to the proper consistency in small batches and immediately applied.

If mortar is used in freezing weather it should be made under cover. Under no circumstances should frozen mortar be used.

### APPLYING THE PLASTER.

Plastering on lath work is generally done in three coats. The first coat is called the scratch; the second, the brown coat; and the third, the white coat, or finish. On brick or stone work the scratch coat is generally omitted.

### THE SCRATCH COAT.

The scratch coat should always be made rich, and should contain plenty of hair or fibre, as it forms the foundation for the brown and white coats. The coat is usually put on from  $\frac{3}{16}$  to  $\frac{1}{4}$  of an inch thick over the laths, and should be pressed by the trowel with sufficient force to squeeze it between and behind the laths, so as to form a key or "clinch". It is this key which holds the plaster to the laths. When the first coat has commenced to harden (the time varying from 2 to 4 days) it should be scarred or scratched nearly through its thickness with lines diagonally across each other, about 2 to 3 inches apart. This gives a better hold for the second coat.

The first coat should be thoroughly dry before putting on the second coat, but if the surface is too dry it should be slightly dampened with a sprinkler or brush as the second coat is put on.

A great deal of plastering is done where the brown coat is applied from the same stage, and as soon as the scratch coat is put on. When done in this way the scratch coat is generally made very rich, and the brown coat largely of sand, the brown coat being worked into the scratch coat so that it really makes only one coat.

### THE GREEN SCRATCH.

Better work is possible by allowing the scratch coat to dry before putting on the brown coat. This takes more labor and more lime than by the "green scratch" method, and, consequently, is not done unless particularly specified. Besides not giving so good a wall, applying the brown coat to the green scratch causes the laths to swell badly. Then when the laths dry out, cracks in the plaster are caused.

### THE BROWN COAT.

The second or "brown" coat is put on from  $\frac{1}{4}$  to  $\frac{3}{8}$  of an inch thick. With this coat all the surface should be brought to a true plane, the angles made straight, the walls plumb, and the ceilings level.

On the walls the plastering can be brought to a true plane by means of the "grounds", if the latter are set true and the wall is not too large or with out openings. On the ceilings, however, there is usually nothing to guide the plasterer in his work, and the consequence is that most ceilings, particularly in domestic work, have a rolling surface which can be detected at the angle of the ceiling and wall.

The only way of obtaining a true plane on the ceiling and on walls when the grounds are not sufficient is by screeding, which is done by applying horizontal strips of plaster mortar 6 to 8 inches wide and from 2 to 4 feet







apart, all around the room. These are made to project from the first coat out to the intended face of the second coat, and while soft are made perfectly straight and in the same plane by measuring with a plumb, straight edge, etc. When the screeds are dry the second coat is put on, filling up the broad, horizontal spaces between them. The walls or ceiling are readily brought to perfectly flat surfaces by means of long straight-edges extending across the screeds.

### THE FINISH COAT.

The method of finishing the wall varies somewhat in different parts of the country, and also with the kinds of surface desired. In some localities, especially in small villages, when the walls are to be papered, no finishing coat is applied, but the brown is smoothly troweled. This reduces the expense but a trifle, and is not to be recommended, as the walls cannot be well straightened, and the roughness of the plaster will show through the paper.

### THE SKIM COAT.

In many of the western states the finishing coat is called the skim coat, and is made of lime putty and fine white sand, generally washed beach sand. The lime is slaked and run through a sieve into a tight box, and then allowed to stand until it becomes of the consistency of putty, when it is taken out and the sand mixed with it. The box containing the putty should be kept covered to keep out dust and dirt, and the putty should not be used until at least a week old.

The skim coat is put on with a trowel, floated down, and then gone over with a brush and a small trowel until the surface becomes hard and polished.

### THE WHITE COAT.

This term is generally used to designate the finishing coat when plaster of Paris is mixed with the lime putty. In most portions of the United States it appears to be the custom to finish the walls with a thin coat of lime putty, plaster of Paris, and marble dust. This makes a whiter wall than the skim coat, and if marble dust is used and the work is well troweled, it will take a good polish. Without the marble dust it will not be hard nor take a polish. For this work the lime is slaked and permitted to form a putty, as with the skim coat. The plaster of Paris and marble dust should not be mixed with the putty until a few moments before using, and then only as much should be prepared as can be used up at once, for if left to stand any length of time it will "set" and become useless. It should be finished by brushing down with a wet brush and immediately gone over with a trowel. The more it is troweled, the harder it will become. In estimating the quantity of materials required for the white coat 90 pounds of lime, 50 pounds of plaster of Paris, and 50 pounds of marble dust should be allowed to 100 square yards.

### SAND FINISH.

When a rough finish is desired the third coat is mixed with lime putty and sand as for the skim coat, except that coarser sand and a greater quantity of it is used. Sometimes a small quantity of plaster of Paris is also mixed with it. Sand finish should be applied before the brown coat is quite dry, and should be floated with either clear, soft pine or cork-faced floats. The







roughness of the surface desired may be conveniently designated by comparing it with the different grades of sand paper.

Sometimes the brown coat is floated to give an imitation of sand finish, but it is impossible to get an even and uniform surface without using a separate coat. Sand finish is often ruled off and jointed to imitate stone ashlar. It may also be colored.

### ESTIMATING PLASTER WORK.

Quantities for 100 square yards.

1. Three Coats, Plaster of Paris Finish, on Wet Laths.  
 10 lbs. 3d nails                      1 1/2 cu. yards sand.  
 1400 to 1500 laths.                      2 bushels of hair.  
 8 to 10 bushels of lime.              100 lbs. plaster of Paris
2. Three Coats. Sand Finish, on Wet Laths.  
 Same as Three-coat work above, except omit the 100 lbs. of Plaster of Paris, and add 1/2 cu. yd. of sand.
3. Two Coats: (Scratch and Brown Coats) on Wet Laths.  
 Same as Three-coat work (plaster of Paris finish) above, except that two bushels of lime and 100 lbs. of plaster of Paris are omitted.
4. Two Coats: (Brown and Finishing Coats) on Brick or Stone Walls.  
 6 to 8 bu. lime                      100 lbs. plaster of Paris.  
 1 1/2 yards sand
5. Scratch coat.  
 1 1/2 bushels hair or fibre              )  
 2 1/2 " Lime                      )-For 1 part lime paste to 2 parts sand.  
 3 1/2 " screened sand              )
6. Brown Coat.  
 1/2 bushel hair  
 2 1/2 bushels lime  
 7 " screened sand.
7. Finishing Coat.  
 Lime putty                      )  
 Washed beach sand or              )-Equal proportions  
 Plasterer's Sand                      )

### Labor and Cost

#### Lathing.

On the average job where laths are 1 1/2 inches wide and 48 inches long a lather should place 175 to 200 laths an hour. This is at the rate of 1400 to 1500 per 8-hour day. Estimating on the basis of square yards of surface covered, a lather should place from 12 1/2 to 13-3/4 square yards an hour or 100 to 110 square yards per day. Estimating on this basis the labor cost of handling and placing 1450 laths (the number required for 100 square feet) is as follows

|                           | <u>Hours</u> | <u>Rate</u> | <u>Total</u> |
|---------------------------|--------------|-------------|--------------|
| Lathers placing the laths | 8            | \$1.71-7/8  | \$5.75       |
| Average per square yard   | 4 3/4 min.   |             | .05 3/4      |

#### Plastering.

The following table shows the amount of ordinary work that can be expected by the hour or day (8 hours) and the labor cost of putting on 100 square yards of plaster. The labor includes one plasterer at \$0.75 (1917) an hour and a helper at \$0.50 (1917) per hour.







| Kind of Work:      | Square Yards Covered: |         | Labor and Cost for 100 Square Yards. |       |             |        |
|--------------------|-----------------------|---------|--------------------------------------|-------|-------------|--------|
|                    | Per Hour              | Per Day | Hours                                | Rate  | Per Sq. Yd. | Total  |
| Scratch Coat:      | 17 1/4                | 138     | 5 1/2                                | \$.75 |             |        |
| Brown Coat         | 16 1/2                | 132     | 5 1/2                                | .50   | \$0.07      | \$6.88 |
|                    |                       |         | 6                                    | .75   |             |        |
|                    |                       |         | 6                                    | .50   | .07 1/2     | 7.50   |
| Finish Coat        | 13 1/2                | 108     | 7 1/2                                | .75   |             |        |
|                    |                       |         | 3                                    | .50   | .07-1/8     | 7.13   |
| Sand Finish        | 11 1/4                | 90      | 9                                    | .75   |             |        |
|                    |                       |         | 4                                    | .50   | .08-3/4     | 8.75   |
| Two Coat Plaster   |                       |         |                                      |       |             |        |
| White Finish:      | 7 1/2                 | 60      | 13                                   | .75   |             |        |
|                    |                       |         | 10                                   | .50   | .14-3/4     | 14.75  |
| Sand Finish        | 6 1/4                 | 50      | 14 1/2                               | .75   |             |        |
|                    |                       |         | 10                                   | .50   | .15 9/10    | 15.88  |
| Three Coat Plaster |                       |         |                                      |       |             |        |
| White Finish:      | 5 1/2-4               | 42      | 19 1/2                               | .75   |             |        |
|                    |                       |         | 15                                   | .50   | .22 1/8     | 22.13  |
| Sand Finish        | 4 7/8                 | 39      | 20 1/2                               | .75   |             |        |
|                    |                       |         | 15 1/2                               | .50   | .23 1/8     | 23.13  |

### MEASURING PLASTER WORK.

Lathing is always figured by the square yard, and is generally included with the plastering, although in small country towns the carpenter often puts on the laths.

Plastering on plain surfaces, as on walls and ceilings, is always measured by the square yard, whether it be one, two, or three-coat work.

In regard to deducting for openings, custom varies somewhat in different parts of the country, and also with different contractors. Some plasterers allow one-half the area of openings for ordinary doors and windows, while others make not allowance for openings other than for those measuring at least 7 square yards. Returns of chimney breasts, pilasters, and all strips less than 12 inches wide, closets, soffits of stairs, etc, are generally figured at a higher rate than plain walls or ceilings, as they are not easy of access. If plastering cannot be done from trestles an additional charge must be made for staging.

Whenever plastering is done by measurement the contract should definitely state whether or not openings are to be deducted.







U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

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BUILDING MATERIALS

MANUFACTURERS' AND DEALERS ASSOCIATIONS

WOOD

GENERAL

Arkansas Soft Pine Bureau, Little Rock, Arkansas.  
California Redwood Association, San Francisco, California.  
Central Iowa Retail Lumberman's Association, Cedar Falls, Iowa.  
Chicago Building Material Exchange, Chicago, Illinois.  
Gum Lumber Manufacturers' Association, Memphis, Tennessee.  
Hickory Products Association, Chicago, Illinois.  
Lumber Dealers' Association of Connecticut, New Haven, Connecticut.  
Michigan Retail Lumber Dealers' Association, Grand Rapids, Michigan.  
National Association of Builders' Exchanges, Philadelphia, Pennsylvania.  
National Builders Supply Association, Cleveland, Ohio.  
National Hardwood Lumber Association, Chicago, Illinois.  
National Lumber Exporters Association, Baltimore, Maryland.  
National Lumber Manufacturers' Association, Chicago, Illinois.  
National Wholesale Lumber Dealers' Association, New York City.  
National Retail Lumber Dealers' Association, Detroit, Michigan.  
New York Lumber Trade Association, New York City.  
North Carolina Pine Association, Norfolk, Virginia.  
Northern Hemlock and Hardwood Manufacturers' Association, Wausau, Wisconsin.  
Northern White Cedar Association, Minneapolis, Minnesota.  
Northwestern Lumbermen's Association, Minneapolis, Minnesota.  
Ohio Association of Retail Lumber Dealers, Xenia, Ohio.  
Retail Lumber Dealers Association of the State of New York, Rochester, New York.  
Southern Cypress Manufacturers' Association, New Orleans, Louisiana, and  
Jacksonville, Florida.  
Southern Pine Association, New Orleans, Louisiana.  
Southwestern Lumbermen's Association, Kansas City, Missouri.  
West Coast Lumbermen's Association, Seattle, Washington.  
Western Pine Manufacturers' Association, Portland, Oregon.  
Western Red Cedar Association, Spokane, Washington.  
White Pine Bureau, St. Paul, Minnesota.  
Wisconsin Retail Lumbermen's Association, Milwaukee, Wisconsin.  
Yellow Pine Manufacturers' Association, St. Louis, Missouri.

FLOORING

Maple Flooring Manufacturers' Association, Chicago, Illinois.  
Oak Flooring Manufacturers' Association, Cincinnati, Ohio.

MILLWORK

National Veneer and Panel Manufacturers Association, Indianapolis, Indiana.  
Southern Sash, Door, & Millwork Manufacturers Association, Atlanta, Georgia.



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Chicago Building Material Exchange, Chicago, Illinois.  
Gum Lumber Manufacturers' Association, Memphis, Tennessee.  
Hickory Products Association, Chicago, Illinois.  
Lumber Dealers' Association of Connecticut, New Haven, Connecticut.  
Michigan Retail Lumber Dealers' Association, Grand Rapids, Michigan.  
National Association of Builders' Associations, Philadelphia, Pennsylvania.  
National Builders Supply Association, Cleveland, Ohio.  
National Hardwood Lumber Association, Chicago, Illinois.  
National Lumber Exporters Association, Baltimore, Maryland.  
National Lumber Manufacturers' Association, Chicago, Illinois.  
National Wholesale Lumber Dealers' Association, New York City.  
National Retail Lumber Dealers' Association, Detroit, Michigan.  
New York Lumber Trade Association, New York City.  
North Carolina Pine Association, Norfolk, Virginia.  
Northern Hemlock and Hardwood Manufacturers' Association, Sausalito, Wisconsin.  
Northern White Cedar Association, Minneapolis, Minnesota.  
Northwestern Lumbermen's Association, Minneapolis, Minnesota.  
Ohio Association of Retail Lumber Dealers, Xenia, Ohio.  
Retail Lumber Dealers Association of the State of New York, Rochester, New York.  
Southern Cypress Manufacturers' Association, New Orleans, Louisiana, and Jacksonville, Florida.  
Southern Pine Association, New Orleans, Louisiana.  
Southwestern Lumbermen's Association, Kansas City, Missouri.  
West Coast Lumbermen's Association, Seattle, Washington.  
Western Pine Manufacturers' Association, Portland, Oregon.  
Western Red Cedar Association, Spokane, Washington.  
White Pine Bureau, St. Paul, Minnesota.  
Wisconsin Retail Lumbermen's Association, Milwaukee, Wisconsin.  
Yellow Pine Manufacturers' Association, Ft. Collins, Colorado.

EXCELLENCE

Hugle Flooring Manufacturers' Association, Chicago, Illinois.  
Oak Flooring Manufacturers' Association, Cincinnati, Ohio.

MINOR

National Lumber and Panel Manufacturers Association, Indianapolis, Indiana.  
Southern Soft, Hard, & Millwork Manufacturers Association, Atlanta, Georgia.



MILLS (Continued)

Turned Ware Association, Grand Rapids, Michigan.  
Wholesale Sash and Door Association, Chicago, Illinois.

MISCELLANEOUS

American Wood Preservers' Association, Baltimore, Maryland.  
Eastern Sh and Wood Box Manufacturers' Association, Boston, Mass.  
National Association of Kitchen Cabinet Manufacturers, Muncie, Indiana.  
National Home Furnishers' Association, New York City.  
National Wood Chemical Association, Bradford, Pennsylvania.

CEMENT - CONCRETE - ASPHALT

Asphalt Shingle Publicity Bureau, Chicago, Illinois.  
Portland Cement Association, Chicago, Illinois.

BRICK - TILE - TERRA COTTA, ETC.

American Face Brick Association, Washington, D. C.  
American Tile Manufacturers' Association, Zanesville, Ohio.  
Associated Tile Manufacturers, Beaver Falls, Pennsylvania.  
Clay Products Association, Chicago, Illinois.  
National Brick Manufacturers' Association, Indianapolis, Indiana.  
National Paving Brick Manufacturers' Association, Cleveland, Ohio.  
National Sanitary Potteries Association, Trenton, New Jersey.  
The Permanent Building Society, Chicago, Illinois.  
United States Pottery Association, East Liverpool, Ohio.

ROCK-STONE-LIME-GRAVEL-SAND, ETC.

Barre Granite Manufacturers' Association, Barre, Vermont.  
Hydrated Lime Bureau, Pittsburgh, Pennsylvania.  
Indiana Limestone Quarrymen's Association, Bedford, Indiana.  
New York & New Jersey Trap Rock Association, Passaic, New Jersey.  
National Association of Marble Dealers, Cleveland, Ohio.  
National Association of Sand and Gravel Producers, Indianapolis, Indiana.  
National Building Granite Quarrymen's Association, Boston, Massachusetts.

HARDWARE

American Hardware Manufacturers' Association, New York City.  
American Iron, Steel, and Heavy Hardware Association, New York City.  
Connecticut Hardware Association, Woodbury, Connecticut.  
Hardware Manufacturers' Association of U. S. A., Cincinnati, Ohio.  
National Retail Hardware Association, Argos, Indiana.  
New England Hardware Dealers' Association, Boston, Massachusetts.  
Southern Hardware Jobbers Association, Richmond, Virginia.

METAL-FIBER-FEEL

Associated Metal Lath Manufacturers, Cleveland, Ohio.  
Association of Stove Manufacturers, Troy, New York.  
Association of Steel Furniture Manufacturers, Cleveland, Ohio.  
Domestic Metal Equipment Association, Boston, Massachusetts.  
Felt Manufacturers' Association, New York City.  
Hollow Metal Window Manufacturers' Association, Chicago, Illinois.



(Continued)

Turned Ware Association, Grand Rapids, Michigan.  
Polonia Cash and Book Association, Chicago, Illinois.

MILK - MILK

American Wood Preservers' Association, Baltimore, Maryland.  
Eastern St. and Wood Box Manufacturers' Association, Boston, Mass.  
National Association of Kitchen Cabinet Manufacturers, Indianapolis.  
National Home Furnishers' Association, New York City.  
National Wood Chemical Association, New York, Pennsylvania.

PAINT - PAINT

Apprentice Painters Publicity Bureau, Chicago, Illinois.  
Painters General Association, Chicago, Illinois.

PLUM - PLUM

American Rose Plink Association, Washington, D.C.  
American Tile Manufacturers' Association, Kansasville, Ohio.  
Associated Tile Manufacturers, New York City, Pennsylvania.  
Clay Products Association, Chicago, Illinois.  
National Brick Manufacturers' Association, Indianapolis, Indiana.  
National Facing Brick Manufacturers' Association, Cleveland, Ohio.  
National Sanitary Fixture Association, New York City.  
The Government Building Society, Chicago, Illinois.  
United States Pottery Association, East Liverpool, Ohio.

ROCK - ROCK

Granite Granite Manufacturers' Association, New York, Vermont.  
Hydrated Lime Bureau, Pittsburgh, Pennsylvania.  
Indiana Limestone Manufacturers' Association, Bedford, Indiana.  
New York & New Jersey Trap Rock Association, New York City.  
National Association of Marble Dealers, Cleveland, Ohio.  
National Association of Sand and Gravel Producers, Indianapolis, Indiana.  
National Building Granite Quarries Association, Boston, Massachusetts.

ROPE - ROPE

American Rope Manufacturers' Association, New York City.  
American Iron, Steel, and Heavy Hardware Association, New York City.  
Associated Hardware Association, New York City.  
Hardware Manufacturers' Association of U.S.A., Cincinnati, Ohio.  
National Retail Hardware Association, Argos, Indiana.  
New England Hardware Dealers' Association, Boston, Massachusetts.  
Southern Hardware Jobbers Association, Richmond, Virginia.

SHOE - SHOE

Associated Metal Lath Manufacturers, Cleveland, Ohio.  
Association of Shoe Manufacturers, New York City.  
Association of Shoe Manufacturers, Cleveland, Ohio.  
Domestic Metal Equipment Association, Boston, Massachusetts.  
Foot Manufacturers' Association, New York City.  
Hollow Metal Window Manufacturers' Association, Chicago, Illinois.



METAL-FIBRE-VELT (Continued)

Metal Finishers Equipment Association, New York City.

PIPE (IRON CONCRETE)

American Concrete Pipe Association, Chicago, Illinois.

Association of Vitrified Pipe Manufacturers, Akron, Ohio.

Cast-Iron Soil Pipe Makers' Association, Somerville Iron Works,  
New York City.

National Pipe and Supplies Association, Pittsburgh, Pennsylvania.

PAINT-VARNISH-GLASS

American Association of Flint and Lime Glass Manufacturers, Inc.  
Pittsburgh, Pennsylvania.

International Association of Master House Painters & Decorators of  
U. S. A., and Canada, Washington, D. C.

National Association of Paint Jobbers, Chicago, Illinois.

National Association of Window Glass Manufacturers, Pittsburgh, Pa.

National Ornamental Glass Manufacturers' Association, St. Louis, Mo.

National Paint, Oil, and Varnish Association, New York City.

National Varnish Manufacturers Association, Philadelphia, Pennsylvania.

Paint Manufacturers' Association of the United States, Philadelphia, Pa.

PLUMBING AND ELECTRICAL EQUIPMENT

Associated Manufacturers of Electrical Supplies, New York City.

Electrical Supply Jobbers' Association, Chicago, Illinois.

National Association of Electrical Contractors & Dealers, New York City.

National Association of Master Plumbers, St. Louis, Missouri.

National Association of Master Steam and Hot-Water Fitters, New York City.

MISCELLANEOUS.

International Acetylene Association, New York City.

National Gas Appliance Manufacturers Exchange, New York City.

Sand Paper Association of the United States, New York City.



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U. S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING.

Information Series No. 34

October, 1919.

COMPARISON OF ROUND AND RECTANGULAR BARNES

The circle contains the maximum area that can be inclosed within a given perimeter, hence advocates of the round barn have assumed that this type is the most economical. The square contains the maximum area that can be inclosed within a given rectangular perimeter, but as it is not always possible economically to house the desired number of animals in a square barn, the rectangular form is used. A building cylindrical in shape affords the maximum storage capacity for grain, liquids, etc., but it does not necessarily follow that cattle and horses, which by nature require rectangular stalls and box stalls, can be most economically housed in a round structure.

The arguments that have been advanced in favor of the round barn are as follows:

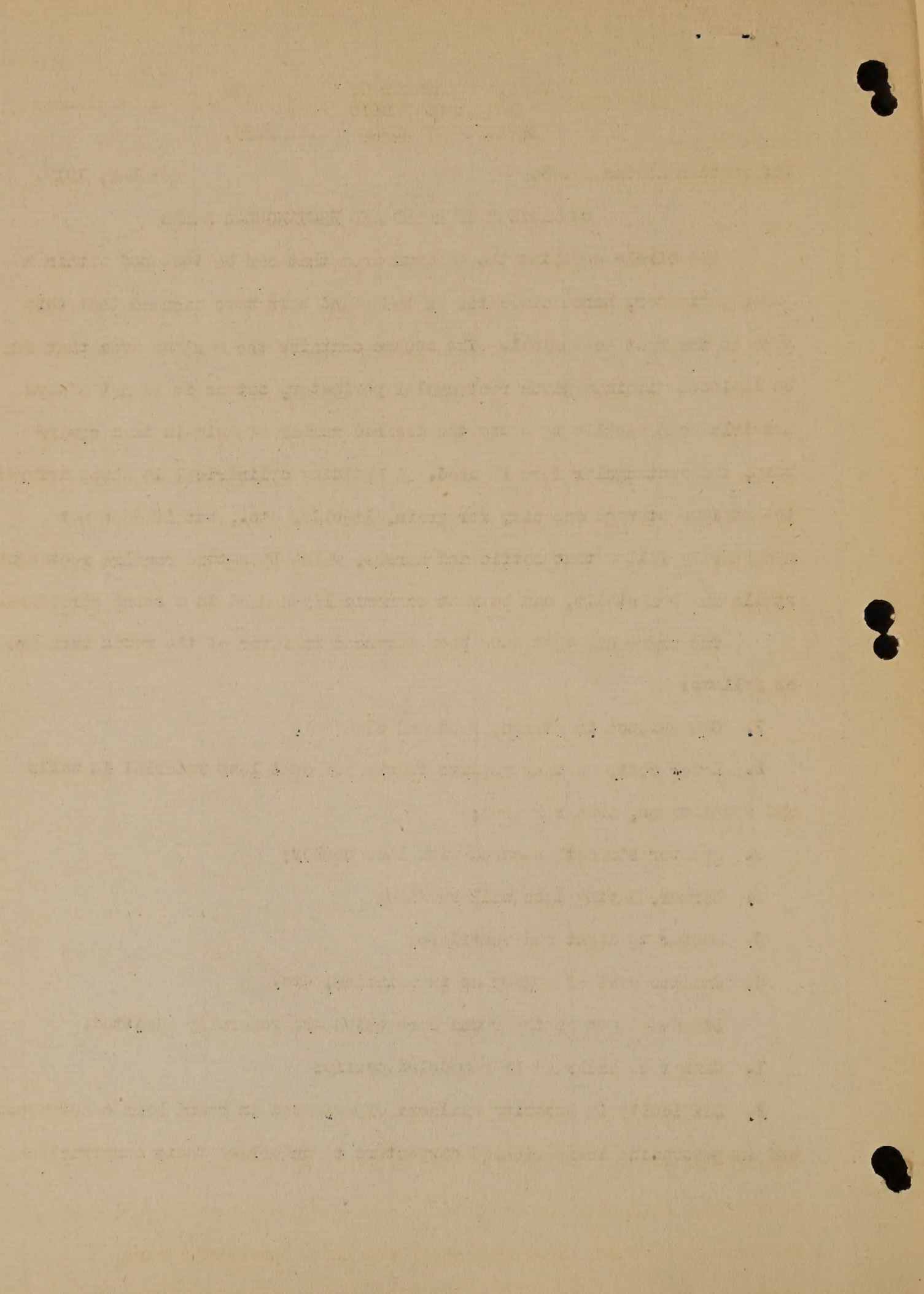
1. Convenience in storing feed and cleaning;
2. Lower cost, as they require twenty per cent less material in walls and foundations, area for area;

3. Greater strength secured with less lumber;
4. Warmer, having less wall surface;
5. Easier to light and ventilate;
6. Smaller cost of upkeep as in painting, etc.

Disadvantages of the round barn which are generally admitted:

1. Cannot be enlarged or remodeled easily;
2. Difficulty in securing builders experienced in round barn construction and in persuading inexperienced carpenters to undertake their construction.







The first claim of advantage - that of storage capacity - assumes the maximum use of the cubical contents. It is not always possible to use the cubical space secured in the round barn to advantage; for example, in the storage of hay a large amount of mow space is wasted, because the circular track, which is used in round barns, cannot be placed near the peak of the roof and consequently at least one third of the storage space cannot be filled. As round barns are generally built, that is, with a

areway on the second floor, the mow space is greater than is required because of the necessary height of the roof plate. Some advocates of the round barn assert that since the roof is self-supporting, posts and girder ties do not interfere with the storage of hay. This is not an advantage over the rectangular barn as the same type of self supporting roof construction can be used without the use of cross ties on the rectangular structure. In the rectangular barn the mow space can be used to the maximum since it is possible to store hay even to the bottom of the hay rack, which is hung practically in the peak of the roof.

A number of manufacturers of barn equipment claim to have solved the difficulties of the circular track in round barns, but one man who has visited more than fifty round barns failed to find a single farmer who has successfully used a circular track for any length of time. It is difficult to keep the carriage on the track when a heavy load is being transported.

Frequently a silo is built in the center of a round barn, thus making for convenience in feeding. There is possibly some advantage in this, since the silo is located nearer to the place of feeding than it would be when placed outside of the barn, and in cold climates the silage is protected from freezing. However, the amount of travel necessary in feeding the cows is not much less in a round than in a rectangular barn. ...







Because of the approximately triangular shape of the cow, stalls in the round barn may be made slightly narrower in front than ordinarily is the case, but the difference is small and is balanced by a corresponding increase in the width of the stalls at the back which increases the distance to be covered in cleaning, thus making the amount of travel approximately the same in each case.

Although the silo in the center of the barn may be a slight advantage in feeding it is a great disadvantage at filling time. It is difficult to fill the silo from the outside of the barn as silage pipes should be placed as nearly perpendicular as possible to avoid clogging. If the silo is filled from the mow floor a large amount of hay storage space is wasted. ~~This may amount to as much as one-quarter of the capacity~~ of the mow. If silo filling time came before the hay harvest this space would not necessarily be wasted, but since the opposite is true this cannot be very well avoided. The space if used at all must be used for other purposes than hay storage.

With respect to the second point of advantage claimed, there may be twenty per cent more material used in walls and foundations of a rectangular barn than in a round barn of the same floor area. Advocates of the round barn in making comparisons between the two types, use the floor area enclosed as a basis. If compared on the basis of capacity, in which the farmer is most interested, a somewhat different aspect is given the discussion. For example, a round barn 60 ft. in diameter is generally used to house thirty-two cows. There is a floor area of 2827 sq. ft. contained within a perimeter of 188.50 ft. Thirty two cows may be housed in a rectangular barn 34 ft. by 64 ft., which gives a floor area of 2176 sq. ft. with a perimeter of 196 ft., and in a barn 36 ft. wide, which is preferable, floor area is 2304 sq. ft. and the perimeter 200 ft.







Thus the perimeter of the rectangular barn is but slightly greater while the floor area to be cleaned is appreciably less. It is true that the greater area of the barn permits of a silo in the center but this does not constitute a saving in cost as the construction of the silo, in most instances, is about the same whether built within the barn or outside.

In comparing the actual cost of construction of the two types it is found that the extra labor necessary in erecting the round barn offsets the saving in material. It does not require much argument to convince one that it is much easier to build a square barn than a circular structure. Briefly some of the difficulties of round barn construction are as follows:

The radius of the circle must be used for reference in laying out all stalls, posts, girders and foundations.

The building of sliding doors is more difficult and generally higher in cost.

The construction of forms for circular concrete walls is unquestionably more laborious and therefore expensive.

If vertical siding or boxing is used the siding does not act as bracing and the round barn so constructed lacks strength. When horizontal siding, which is preferable, is used it entails more labor in nailing the boards on the studding, since the boards must be bent to conform in the circle and the ends well nailed. This is more difficult when drop siding is used than when novelty siding is employed. Horizontal siding is preferable because each board acts as a hoop.

In spacing the joists and rafters the outer ends are often overloaded or spaced too far apart, while the inner ends are so close together that more timber is used than is necessary to support the load and nailing is difficult.







Sills and plates must be built up of 1 inch boards to form a hoop or made of sectors cut from heavier stock. This means a waste of material and extra sawing and nailing. Unless a power saw is used the cutting of sectors involves a great deal of labor.

If stock lumber of the usual lengths is used in flooring the row, considerable material is wasted due to the uneven spacing of the joists and extra labor is necessary in sawing the flooring since each board must be cut on a miter.

The third point of superiority may be admitted since it is a well known fact that the circular structure, where each board acts as a band or hoop to tie the building together, must necessarily be stronger than a building of rectangular shape. However, the rectangular barn can be built sufficiently strong when properly braced to withstand strong winds. Where strong winds must be considered it is generally wise to use the barn as a windbreak for the stock yard and for this purpose the round barn is not so desirable as a rectangular building.

With reference to the fourth point it may be said that a round barn is not necessarily warmer than a rectangular barn. During the winter months the sun rises in the southeast and sets in the southwest so that less than half of the windows will admit sunlight during the winter months, and the north half of the exterior wall is not warmed by the sun at all. On the other hand the rectangular barn, placed with the long axis north and south, presents two sides and one end to the sun the year around. The distance from the side walls to the center of a 36 ft. rectangular barn is 18 ft., while in a round barn of 60 ft. diameter it is 30 ft. This is a very important consideration in cold climates. In a round barn containing a silo the north half receives practically no sunlight at all.







The statement that a round barn is easier to light and ventilate cannot be substantiated. As explained in the preceding paragraph, it is more difficult for the light to penetrate to the center of the barn and it is not possible to obtain direct sunlight in all parts of the barn.

If the round barn is built of greater diameter than 60 ft. as it is sometimes done, having two rows of cattle in place of one, then this disadvantage is augmented, and direct sunlight never reaches the center of the barn. If windows are placed close enough together to secure the proper window area for the amount of floor space it is sometimes difficult to secure proper bracing and support for the framing.

It is often difficult to ventilate the round barn properly and this is especially true in case of the barn having a large diameter.

The advantage claimed under the sixth heading is based on the assumption of there being less wall surface to paint. In this one item there may be a saving in upkeep, but in other respects there can be very little difference in maintenance charges.

While the round barn not larger than 60 ft. in diameter may be used to advantage in housing loose stock with possibly a small number of dairy cows, it probably will not be seriously considered for other purposes.

The foregoing is of course based upon the methods of construction and the uses common in the middle west portion of the country and may not be entirely applicable in the extreme south.







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

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Information Series - No. 35

December, 1919.

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USES OF COLD WATER PAINTS

(Whitewashes, Calceimines, and Cement Washes)

Cold water paints frequently are used on farm outbuildings to protect them from the weather and to improve their appearance instead of oil paints which are considerably more expensive. They serve the purpose very well when properly prepared and applied, but are not so durable as good oil paints and must be more frequently applied. Cold water paint, properly mixed and applied in dry weather, should last two years.

Owing to the high cost of oil paints it is a temptation to use whitewash on buildings that have already been painted with oil. It is not advisable to do this as whitewash does not adhere well to oil painted surfaces. It should be applied to clean dry wood in order to obtain best results. If an oil painted building needs repainting and the substitution and continued use of whitewash is desired, the old oil paint should be removed. This is accomplished by the use of a paint remover or blow torch, the loosened paint being removed with a scraper or steel brush. The expense involved in removing old paint would not be warranted in the case of a large or valuable building which, in all probability, would require but a single coat of oil paint to put it into good shape. Whitewash might be substituted on minor structures which do not warrant the continued use of oil paint. In this connection, however, it should be born in mind that a group of farm buildings looks best when they are all painted alike, that is, with the same colors. If whitewash is used in a minor structure, it should be tinted to match the oil paint with which the important buildings have been treated.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
DIVISION OF HORTICULTURE

December, 1919.

Investigation Series - No. 35

TESTS OF PAINTS FOR PAINTING

(Paints, Colors, and Coatings)

Good water paints, especially the ones in this collection, are to be used  
from the moment and to improve their appearance instead of all kinds  
which are considerably more expensive. The better the paint, the better  
it is prepared and applied, but are not so durable as good oil paints and  
must be more frequently applied. Good water paint, properly mixed and applied  
in dry weather, should last two years.  
Coming to the high cost of oil paints it is a temptation to use cheap  
ones on buildings that have already been painted with oil. It is not  
to be that the oil paint does not adhere well to oil painted surfaces.  
It can be applied to clean dry wood in order to obtain best results. It can  
oil painted buildings, especially the unpainted and containing the  
of oil paint is desired. The old oil paint should be removed. This is done  
by the use of a paint remover or a solvent. The following paint  
remover with a solvent or steel brush. The expense involved in removing old  
paint will not be warranted in the case of a large or valuable building which  
in all probability, would require but a single coat of oil paint to put it into  
good shape. This might be necessitated on minor structures which do not  
warrant the continued use of oil paint. In this connection, however, it should  
be born in mind that a group of large buildings looks better when they are all  
painted alike, that is, with the same colors. It is suggested to use in a minor  
structure, it should be tried to match the oil paint with which the structure  
buildings have been treated.



Whitewash is the cheapest of all paints and for certain purposes it is best. Calcimine and similar paints dry by reason of the evaporation of the water and, unless some glutinous substance is incorporated in the mixture, will not adhere for any length of time. For this purpose, flour paste, milk, casein, glue, molasses, sodium silicate and soap solutions are commonly used. It is inadvisable to use whitewashes containing milk, flour, and glue on interior surfaces which are subject to dampness as the organic substances are apt to decompose. Even in mixtures containing organic substances intended for use in dry places it is well to incorporate some preservative such as zinc sulphate, salt, alum or formalin to prevent putrefaction.

Lime is the basis of whitewash which, because of its antiseptic properties, is used for coating interior walls, and ceilings of cellars, stables and outbuildings. Its use helps to keep premises sweet and clean but it is not a reliable disinfectant, that is, destroyer of disease germs. The introduction of a small quantity of crude carbolic acid, creolin or lysol adds to the whitewash a certain value as a disinfectant.

Ordinary whitewash is made by slaking quick lime in water. The lime should be placed in a pail or barrel and the water poured over it; the container should then be covered with a heavy cloth or board and allowed to stand for about one hour. When insufficient water is used the lime is not completely hydrated and becomes scorched. If, on the other hand, too much water is added, the slaking action is retarded through lowering of the temperature. Scorched lime generally is lumpy, hence it is important that the proper amount of water be used in slaking and a subsequent addition of water made in order to produce the consistency proper for brushing.

Commercial hydrated lime may be used for making whitewash but it is not as desirable as quick lime because the process of hydration lessens its adhesive quality.







Following are formulas for mixing whitewashes for different uses:

\*FACTORY WHITEWASH: (Interior) : For walls, ceilings, posts, etc.

(1) Sixty-two pounds (1 bushel) quicklime; slake with 15 gallons water; keep barrel covered until steam ceases to rise; stir occasionally to prevent scorching.

(2) Two and one-half pounds rye flour; beat in one-half gallon of cold water; add two gallons of boiling water.

(3) Two and one-half pounds common rock salt; dissolve in two and one-half gallons of hot water.

Mix (2) and (3), then pour into (1) and stir until all is well mixed.

\*WEATHERPROOF WHITEWASH: (Exterior) : For buildings, fences, etc.

(1) Sixty-two pounds (1 bushel) quicklime; slake with 12 gallons of hot water.

(2) Two pounds common table salt; one pound sulphate of zinc; dissolve in two gallons of boiling water.

(3) Two gallons skimmed milk.

Pour (2) into (1), then add the milk (3) and mix thoroughly.

\*LIGHTHOUSE WHITEWASH: (1) sixty-two pounds (1 bushel) quicklime; slake with 12 gallons of hot water.

(2) Twelve pounds rock salt; dissolve in six gallons of boiling water.

(3) Six pounds Portland cement.

Pour (2) into (1), then add (3)

GOVERNMENT FORMULA: Slake half a bushel of quick or lump lime with boiling water keeping it covered during the process. Strain it and add a peck of salt dissolved in warm water; three pounds ground rice put in boiling water and boiled to a thin paste; half a pound of powdered Spanish whiting and a pound of clear blue, dissolved in warm water; mix these well together





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and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace; and when used put it on as hot as possible, with painter's or whitewash brush.

\*Note:- Alum added to a lime whitewash increases its adhesive quality. An ounce to the gallon is sufficient

Flour past answers the same purpose but a preservative such as zinc sulphate should be added.

Molasses renders the lime more soluble and causes it to more deeply penetrate the wood or plaster; a pint of molasses to 5 gallons of whitewash is sufficient.

Silicate of soda solution (about 35 degrees Baume) in the proportion of 1 to 10 of whitewash produced a fire-resistive cement.

A pound of cheap bar soap dissolved in a gallon of boiling water and added to about 5 gallons of thick whitewash will impart a gloss like that of oil paint.

#### CEMENT WHITEWASH

The following recipe for cement whitewash has been successfully used in cold storage warehouses. It adheres strongly to cement, brick or wood and does not run off.

Slake one-half bushel of lime with boiling water, adding the water slowly and stirring constantly until a thin paste results. The lime will be lumpy if the water is added too freely and the mass not properly stirred. Add one-half peck of salt to the lime paste; stir thoroughly; add water to bring the whitewash to the proper consistency. Add a good handful of Portland cement and a tablespoonful of ultra marine blue to each pail of whitewash. The cement and the blue powder should be added just before the wash is to be used and should be stirred thoroughly, otherwise the whitewash will be streaked.







The cement makes the whitewash adhere strongly to any surface and the bluing counteracts the grayish color of the cement the result being a white coating.

#### CARBIDE WHITEWASH.

The carbide residue from acetylene gas generators can be used to advantage as a whitewash for fruit trees since, mixed with a diluted solution of sulphate of iron peroxide, it destroys moths and insects which deposit eggs on the stems and branches of the trees. When mixed with a weak solution of carbolic acid it is valuable as a sanitary whitewash for the walls and ceilings of cattle sheds, stables, chicken houses and other out buildings. The addition of a small amount of bichromate of potash or soda to the residue imparts a very pleasing yellow color. One-half dram of bichromate of potash mixed with 25 drams of water are adequate for coloring two pounds of residue.

#### CALCIMINES

Calcimines differ from whitewashed in that they have as a basis whiting or carbonated lime instead of caustic lime. Whiting has no adhesive properties and requires the addition of a binder such as casein or glue. The following is a formula for stock calcimine.

Mix sixteen pounds of Paris white or dry whiting with one gallon of water and stir until free from lumps; add to this one-half pound of glue dissolved in a pint of water. (Dissolve glue in a water bath.) This will produce two gallons of paint weighing 12-3/4 pounds per gallon. It will be of the proper consistency for brushing and may be used immediately although generally it is preferable to permit it to stand for a half hour before using. Under average conditions this amount will cover 270 sq. ft. of plaster surface, 180 sq. ft. of brick surface, 225 sq. ft. of wood surface; Any tints may be used to give the paint the desired color. Since colors fade upon drying, test panels should be prepared in order to obtain the desired ultimate shade.







Casein Paint -- Exteriors: To ten pounds of pure casein add eight pounds of air slaked lime, one pound of pulverized borax and sixty pounds of whiting. Mix the ingredients thoroughly and keep in a sealed package until wanted for use. Stir into water, preferable warm, to produce the desired consistency.

Interior Calceimine: Mix thoroughly in the dry state, eight pounds of pure casein, one pound of soda ash (58%), sixty pounds of "gilders" bolted whiting, and twelve pounds of plaster of Paris. Add water and stir until the desired consistency is obtained and allow to stand a short time before using so that the casein may dissolve.

Waterproof Calceimine: Heat one pound of casein with one pint of cold water and then dilute the mixture with three quarts of cold water and eight fluid ounces of ammonia. Stir the whole solution until a smooth jelly is produced after which add one-quarter ounce of formaldehyde. This liquid acts as a binder for the whiting or any other pigment which is not affected by alkali. (See Coloring Materials.) The desired pigment is stirred into the casein liquid until a moderately thick paste is obtained. The solution is then diluted with water, alcohol, turpentine or linseed oil as desired to the proper consistency for painting.

#### CEMENT WASHES

Cement washes often are preferred to whitewashes for the protection of exterior surfaces. They are made by mixing a sufficient quantity of Portland cement with water to secure the desired consistency. Sand and cement mixed dry in the proportion of one to three and then mixed with water sometimes is used as a paint. It is a common practice to treat the interior walls of a concrete silo with a cement wash each year before filling. This tends to make the walls more impervious to water and to exclude air. Such a wash often is used to give finished appearance to rough concrete walls after the forms have been removed.







BUTTERMILK PAINT: Exterior : Mix Portland cement and buttermilk using three pounds of Portland cement for each gallon of buttermilk, adding the desired amount of coloring matter. The paint should be applied soon after it is made and must be stirred frequently while it is being used to keep the cement from settling to the bottom of the vessel. Coloring matter which may be used with such washes is discussed in a subsequent paragraph. Buttermilk paint is adapted to outside work where a glossy surface is not important. It is also good for covering pruning cuts and other injuries to fruit trees. For this purpose a greater proportion of cement should be used to make the paint thicker.

#### COLORING MATERIALS

Color pigments that are not affected by lime, such as yellow ochre, sienna, umbers, Venetian red, para red, maroon oxide, ultra marine blue, ultra marine green, chrome oxide, bone black, lamp black, etc., may be used for tinting whitewashes, calcimines and cold water paints. Lamp black when used for tinting, should be stirred in hot water with soap or in a cold water solution of borax, the alkali in which overcomes the greasy nature of the lamp black.

#### APPLICATION

Generally whitewashes and cold water paints are applied with a broad flat brush five inches or more in width, the liquid being spread lightly over the surface with no attempt to brush it in as with oil paints. Whitewash also may be applied with a spray pump or air brush. This method saves considerable labor in application as a large surface can be covered in a short time. However, there is a considerable waste of material as it is not possible to confine the spray to the surfaces to be whitewashed. If canvas or paper is spread over surrounding objects and surfaces, the labor in cleaning up is materially lessened.



INTERVIEW WITH THE INTERVIEWER: The following account was given by the

three persons of the following account for each person of the following account

the amount of coloring matter. The paint should be applied from the

it is made and must be stirred frequently while it is being used on the

surface from sitting in the bottom of the can. Coloring matter should be

used with each wash as directed in a subsequent paragraph. Instructions

paint is applied to outside with a glass surface is not a surface. It

is also good for covering various parts and other surfaces so that they

this purpose a greater proportion of cement should be used to make the paint

thicker.

### COLORING MATTER

Color pigments that are not affected by lime, such as yellow ochre,

ultramarine, vermilion, red, green, white, blue, brown, black, etc., may be used for

various purposes, such as, for example, for painting, etc., may be used for

various purposes, such as, for example, for painting, etc., may be used for

for painting, should be stirred in hot water and kept in a cold water

solution of borax, the amount in which overcomes the tendency of the

large black.

### APPLICATION

Generally, whitewash and cold water should be applied with a brush

that brush two inches or more in width, the liquid being spread lightly over

the surface with no attempt to brush it in or with oil. Whitewash may

may be applied with a spray pump or air brush. This method saves considerable

labor in application as a large surface can be covered in a short time. How-

ever, there is a considerable waste of material as it is not possible to cover

the surface to the surface to be white. It is better to have it

spread over surrounding objects and surfaces, the labor in cleaning up is

materially lessened.



One man with a five inch brush should be able to coat the following surfaces in one hour:

|                                             |                            |
|---------------------------------------------|----------------------------|
| Rough stone walls                           | 22 sq. yds. or 198 sq. ft. |
| Smooth walls                                | 38 " " " 342 " "           |
| Brick walls                                 | 20 " " " 180 " "           |
| Flat surfaces, such as bench work or floors | 40 " yds.                  |
| Ceilings, where a step ladder is used       | 25 " "                     |



One can with a five inch beam should be able to cover the following

distances in one hour:

|                           |                                             |
|---------------------------|---------------------------------------------|
| 35 sq. ft. or 120 sq. ft. | Rough stone walls                           |
| 30 " " " 212 " "          | Smooth walls                                |
| 20 " " " 180 " "          | Brick walls                                 |
| 10 " " " 90 " "           | Flat surfaces, such as porch work or floors |
| 5 " " " 45 " "            | Cellars, where a step ladder is used        |



Superseded  
7.13.1078

UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING.

Information Series No. 36.

October 6, 1916.

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C O N S T R U C T I O N   O F   I C E   H O U S E S  
-----

SIZE AND DIMENSIONS

1. The meltage of ice stored in an ice house may be said to be directly proportional to the surface exposed to the air or packing material. Therefore it is advisable to pile ice for storage in the form of a cube, since this form gives the minimum of exposed surface for the greatest volume. Consequently the length, breadth and height of an ice house should be approximately the same.
2. A solid block of ice, a foot cube, weighs about 57 pounds, but the amount of ice that a house of a certain size will hold, will depend upon the way the ice is stored. Generally, a cubic foot of the ice house may be expected to hold the following quantities:

|                                                                                    |               |
|------------------------------------------------------------------------------------|---------------|
| Ice thrown in at random, about.....                                                | 30 to 35 lbs. |
| Ice thrown in in irregular pieces and broken<br>sufficiently to pack closely ..... | 35 to 40 lbs. |
| Ice piled loosely .....                                                            | 40 to 45 lbs. |
| Ice piled closely and with very slight crevices<br>between .....                   | 45 to 50 lbs. |

FILLING THE HOUSE

3. Since the amount of ice which will melt in an ice house is largely determined by the exposed area, the advantage of having the whole quantity as near as possible one compact mass, can well be appreciated. Therefore, it is well to exercise special care in filling the house. As it is put in, the ice should be piled in such a manner that in melting and shrinking, the pressure will not be in the direction of the walls.
4. Pitching the floor slightly toward the center of the house as mentioned under Floor Construction will tend to prevent any sliding toward the outer walls. The first layer should be piled on a thick bed of not less than 12 inches of sawdust or packing material and there should be left at least this same amount of clearance between the ice and walls, which should be filled with the packing material rammed tightly as the ice is put in. (See Fig. 1, Sheet 1) This provides improved keeping possibilities, irrespective of the type of wall construction. Cracks and crevices between blocks of ice are detrimental and should be guarded against. They allow a circulation of air which increases meltage. It is inadvisable to fill the space between the blocks by throwing in irregular pieces of ice or fine chips. If the filling is done in freezing weather, which is advisable, a little water poured in the cracks will freeze and fill them.







## MELTAGE

5. The waste of ice in an ice house is largely caused by meltage from the top, sides and bottom. It seldom and probably never takes place, under proper ice house conditions, inside a pile of ice. The causes of waste from the top and sides are circulation of air and penetration of heat through the walls and loft, while the meltage in the bottom is due to poor floor construction affording insufficient insulation from the earth. The circulation of air is produced by cracks or openings near the floor through which cold air escapes, being replaced by warm air entering at the top of the house and striking the ice on its downward passage. Tight wall construction, especially at the bottom, will reduce this circulation to a minimum. It is therefore of much more importance to stop the escape of cold air from the bottom than to provide a house tight at the top.

## INSULATION

6. The completeness of the insulation whereby the ice is protected from heat and air is of the utmost importance. As materials of which the walls of buildings are usually constructed transmit heat quite rapidly, it is necessary to "line" the walls with materials that will retard this transfer of heat to a greater degree. Therefore the use of low value heat transmitting insulating materials provides better means of reducing the meltage loss.
7. One of the best insulators against heat is still or perfectly motionless air. Therefore the problem is to so confine the air that in reducing its circulation to a minimum, the conductivity of heat through the material is not allowed to become a detrimental factor. It should be clearly understood that the commonly called "dead air space", i.e., a space varying from 1/2 inch to 1-1/2 inches between two walls, and filled with air, presumably dead, is not a means of preventing this circulation of air. It may best be accomplished by properly constructing spaces and filling them with some sort of insulating material in bulk. These insulating materials confine the air in minute spaces and their value depends upon the number of these minute spaces in a certain quantity of the material. Generally, it may be said that the lighter the material, the better insulator it is, owing to the microscopically confined air in the cells or structure of the material itself. Their value also depends upon the density to which they are packed. If packed too loosely, they will permit air circulation, and if packed too closely, they will cause the conduction of heat to a greater degree. With the majority of materials in use, the best results seem to be obtained when packed to a density of from 8 to 10 pounds per cubic foot. The list below prepared from experiments with ice boxes of the same construction and all exposed alike, will show the relative meltage of the ice when the more commonly obtainable insulating







materials were used. The meltage which occurred in the box insulated with chaff (cut-up straw) has been considered as the standard and its value expressed by 100.

|                                     |     |
|-------------------------------------|-----|
| Cotton dried in a warm room.....    | 79  |
| " " " " loft.....                   | 88  |
| Husk of barley dried in a loft..... | 90  |
| " " wheat " " " " .....             | 92  |
| " " oats " " " " .....              | 94  |
| Leaves " " " " .....                | 96  |
| Chaff " " " " .....                 | 100 |
| Husk of rice " " " " .....          | 101 |
| Wheat straw " " " " .....           | 110 |
| Sawdust " " " " .....               | 114 |
| Peat, dry, " " " " .....            | 116 |
| Sawdust, green .....                | 170 |
| Peat, moist.....                    | 260 |
| Sawdust thoroughly wet.....         | 260 |
| Peat " " .....                      | 320 |
| Loam " " .....                      | 560 |
| Sand " " .....                      | 630 |

8. From the above the advantage of having all material absolutely dry may be seen, since the more moisture contained in a material, the better it conducts the heat and the poorer it is as an insulator.

9. The insulating paper used should be of excellent quality. Besides being air and water proof, it should be odorless, especially if it is to be used for cold storage rooms in which may be kept perishable edibles. It should have strength and durability, and should not be brittle or liable to crack in low temperatures as this tends to make it difficult to handle and results in a leaky insulation.

10. There are many insulating papers on the market, some of which are reliable and durable, but the so-called rosin-sized, oiled and tar-coated or tar-saturated papers should be avoided on account of their odor, especially for cold storage rooms, as mentioned above, and the rosin-sized papers also, on account of certain elements entering into their composition which tend to cause disintegration. The so-called "coated" papers, that is, those coated on both sides, and having a light-colored center, may probably disintegrate sooner or later if unfavorable conditions arise. The papers from which the best results may be expected are those that have been saturated and thoroughly impregnated with pure asphalt or similar material, or having a center layer of asphalt. These may be considered practically indestructible when used for cold storage insulation. These high grade papers will be found to be more expensive in first cost but their durability tends to make them cheaper in the end. The cost of using good papers is usually less than 5 per cent of the total cost of the insulation, and as waterproof and air tight paper is the vital feature of good insulation, it is usually considered poor economy to select an inferior grade. When the papers are applied, the







greatest care in lapping around corners, etc., should be exercised, and all joints should be lapped at least 2 inches. (See B, Fig. 5, Sheet 2)

11. One of the chief requirements in the use of wood for cold storage construction is that it should be odorless. This applies particularly to the sheathing and finish of the inside of cold storage rooms which may be used for sensitive goods. All lumber that is used for insulating walls should be thoroughly dry in order to get the best results in efficiency and durable insulation. If the lumber is even partially green, it may carry a considerable amount of moisture with it into the insulation, causing more or less injury. The use of unseasoned lumber should therefore be carefully guarded against. If insulation is erected during cold weather, it may be necessary to keep fires going so as to have all materials as dry as possible. All boards for sheathing should preferably be dressed and matched to give better air tight and waterproof construction and stronger work.

#### DRAINAGE

12. Special attention should be paid to the question of drainage. No surface water should be allowed to flow into or through the building. The meltage from the ice should be quickly disposed of. If the house is to be built on a sand or gravel soil where drainage is good, there should be no trouble from this source. If, however, there is clay soil under the building, it may be advisable to excavate a few inches and fill with coarse gravel, as shown in Fig. 5, Sheet 2. Sometimes it may be necessary to provide a drain by laying a porous tile under the floor along the center and sloping coarse gravel toward it. This drain should be properly trapped or sealed, by using either an S or bell trap, to prevent warm air from entering the building through the floor. Where conditions demand, it may be necessary to lay a drain tile around the building in addition to the one through the center, as shown in Fig. 1, Sheet 2.

#### WALL CONSTRUCTION

13. The building of an efficient insulating wall requires the very best of workmanship after a careful consideration of the method and purpose of its construction.
14. There was at one time and there still exists in the minds of some, a common idea that the insulated walls of an ice house should have air spaces, which if "dead" - that is, all connections with the outside air prevented - are fully as good or even better insulators than the space filled with sawdust or other filling material. This is now considered by many to be a mistake. In a vacant space between a cold and warm wall, a circulation of the confined air, however slight, will always take place, as indicated by the dotted arrows in Fig. 3, Sheet 1, conducting the heat from the warm wall to the cold one. If such a space is closely packed with a dry insulating material, the







circulation, while not entirely prevented, is greatly retarded. Air tight walls will stop the entrance of outside air to the chamber, and prevent, to an extent, conduction, and several partitions of paper or boards in the wall are therefore useful, but the "dead air space" is of comparatively small account.

15. By referring to Fig. 2, Sheet 2, the question of air circulation may be more clearly understood. Remembering that the circulation of air in a filled space is nowhere near as rapid as it would be were the space empty, the circulation is just as surely there. If it is assumed that the space shown in Fig. 2, Sheet 2, is contained between a layer of boarding on the outer or warm wall and on the inner or cold wall, and that these layers are composed of rough lumber, which would mean that there would be cracks and openings between the boards through which the air might pass, and since warm air is lighter than cold air, it may readily be seen that air would penetrate near the top of the wall, circulate to the inner or cold side of the wall, go down the cold side, and eventually gravitate out at the bottom, as shown by the solid line arrows. There will also be some circulation, as shown by the dotted line arrows, within the space between the studding, which is independent of this "in and out" circulation just described. In addition, there will still be a circulation into the cold room at the top and out at the bottom.

16. This circulation cannot be entirely prevented, for however carefully the space between walls may be packed with insulating material, some circulation air will continue to pass down along the cold side of the wall and up in the outer or warm side. Therefore the outer surface of the wall of insulating material (See A, Fig. 5, Sheet 2) should be practically air tight. If it is not, moisture will find its way in with the air, flowing in through the filling material, and as it comes in contact with the cold side of the wall, it will be condensed and deposited on this side. The gradual saturation of the insulating material is the result, with a consequent decrease in its value as a heat insulator. This action will be most pronounced on a warm day in the summer when the humidity is high. The idea is prevalent in the minds of some that the moisture which collects in the material at the inside wall passes through the woodwork from the ice, but as explained, it is really due to a circulation of moisture laden air.

17. Referring to Fig. 3, Sheet 2, there is shown a practically air tight wall construction. The studding is boarded on the exterior with surfaced boards, which are covered with a good insulating paper which is perfectly air tight and water proof, and then matched boards cover this. Thus, the paper, tightly clamped between two smooth boards, makes practically a perfectly sealed surface both on the outer and on the inner







surface of the insulated wall. The circulation as shown by arrows is confined entirely to the space within the air tight surfaces and consequently there is no penetration of warm, moisture-laden air with its ill effects.

18. Fig. 4 and Fig. 5, Sheet 2, illustrate another method of using the air tight and water proof paper which is quite often employed. It is probably somewhat less expensive and produces good results.

19. There are many types of insulating walls, and on Sheet 3 are shown some examples, the relative values being indicated by the "Loss".

#### FLOOR CONSTRUCTION

20. The floor of an ice house is too often given little consideration. It is an important feature, and a properly constructed floor will easily pay for itself in satisfaction given in the reducing of meltage from the bottom of the ice pile.

21. It should be constructed so as to provide means for good insulation, and in Fig. 5, Sheet 2, is shown a suggested method of construction. The joists may be spaced 16" to 24" on centers and a space of 2" should be left between each two floor boards. The spaces between the joists should be filled with insulating material tightly rammed. This material should be absolutely dry when rammed and if the house is to be refilled, the material should be all cleaned out and thoroughly dried before using again. Chaff, leaves, or husks should not be used for this insulation since they easily ferment, develop heat and rot.

22. It is well to have the floor of the house entirely independent of the walls, so that there is no danger of damaging the tightness of the building if any settling of the ice occurs. This may be accomplished by having the floor joists stop at the walls and not set in the foundation walls. (See Fig. 5, Sheet 2)

#### CONCRETE FOR ICE HOUSE CONSTRUCTION

23. In using concrete for ice house construction, it should be understood that concrete has no particular insulating value, and it is, of course, necessary to construct an inner insulating wall. A simple construction for a house of this nature is suggested in Fig. 3 and Fig. 4 of Sheet 1.

24. In constructing a concrete floor the excavation should be made and the lower concrete slab poured at the time the foundation walls are poured. After it hardens, an insulating floor using any of the so-called insulating materials may be used. Then pour a concrete floor on top of this, sloping it toward the center and being sure to fit it with a water seal.

25. For this construction, it is advisable that it be waterproof, and this Office recommends the oil-cement concrete process described in Department of Agriculture Bulletin No. 230. A copy may be procured upon request.







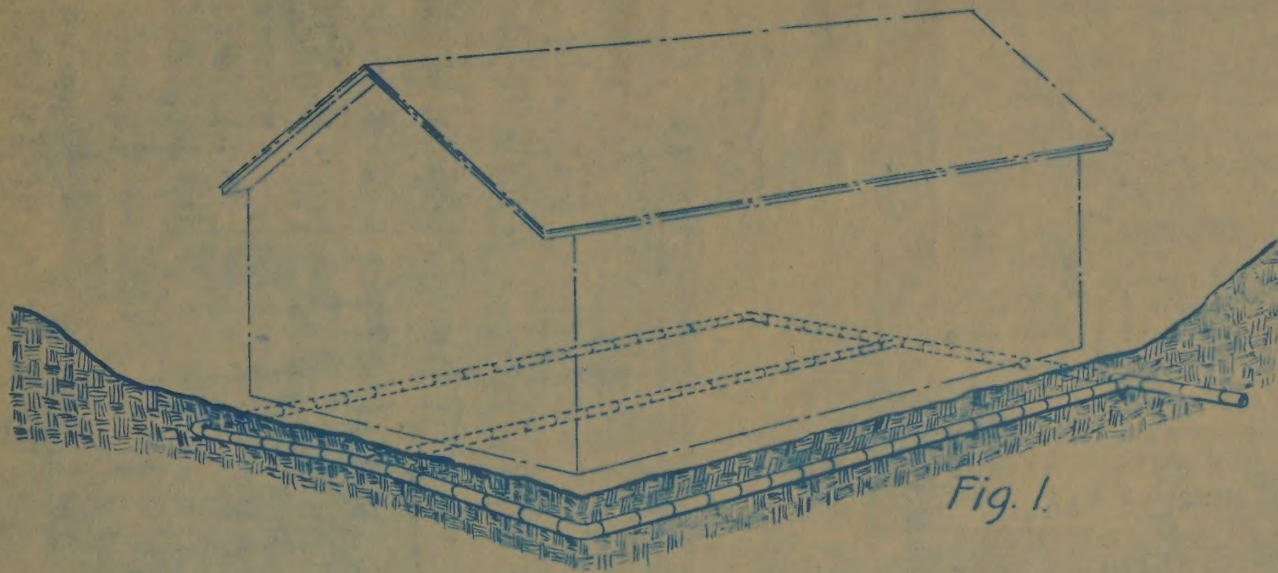


Fig. 1.

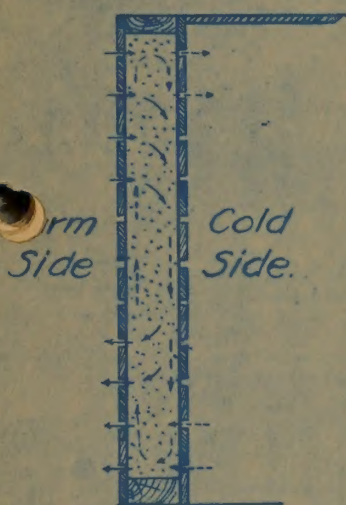


Fig. 2

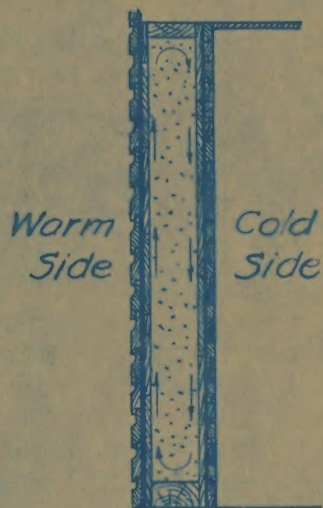


Fig. 3

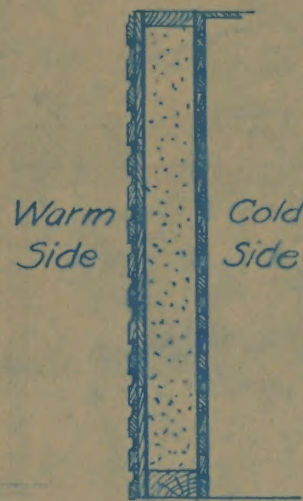


Fig. 4

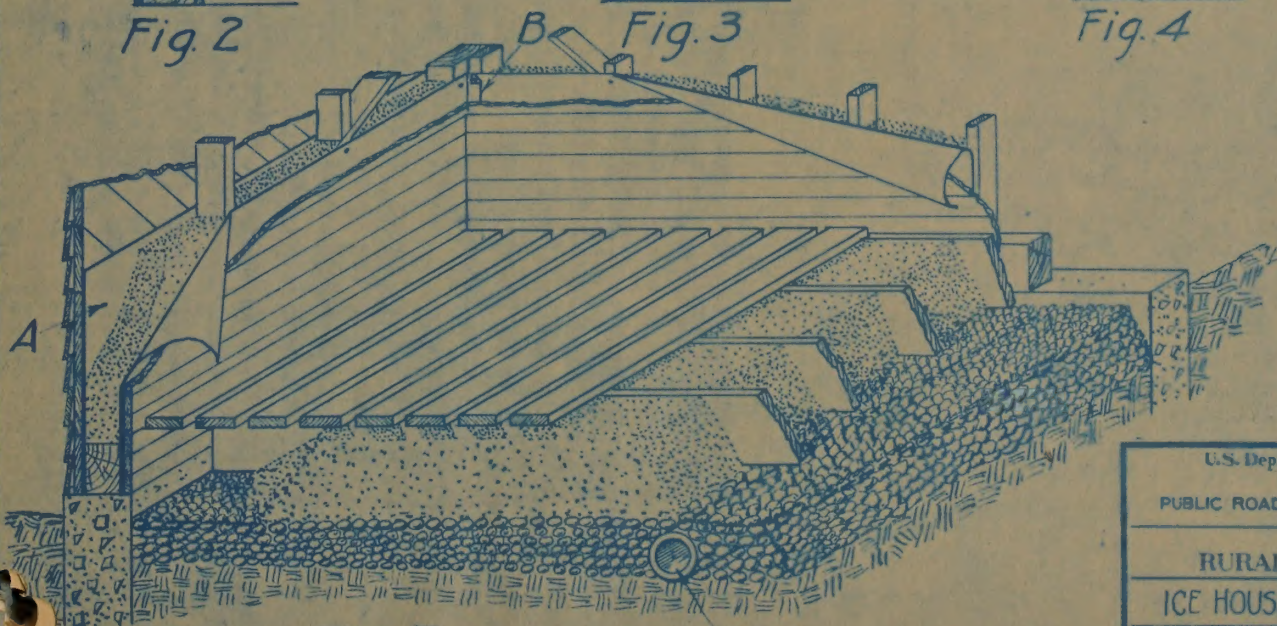


Fig. 5

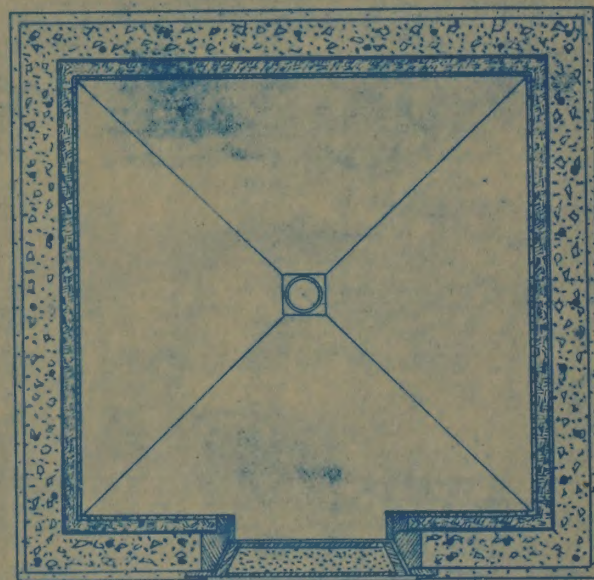
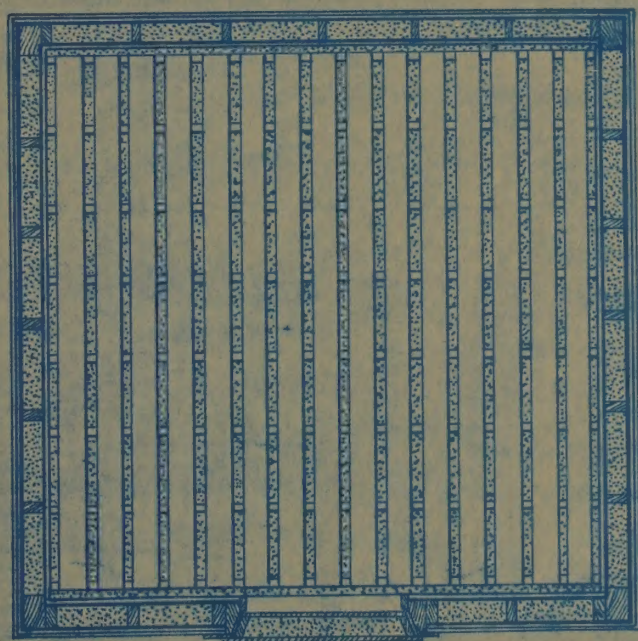
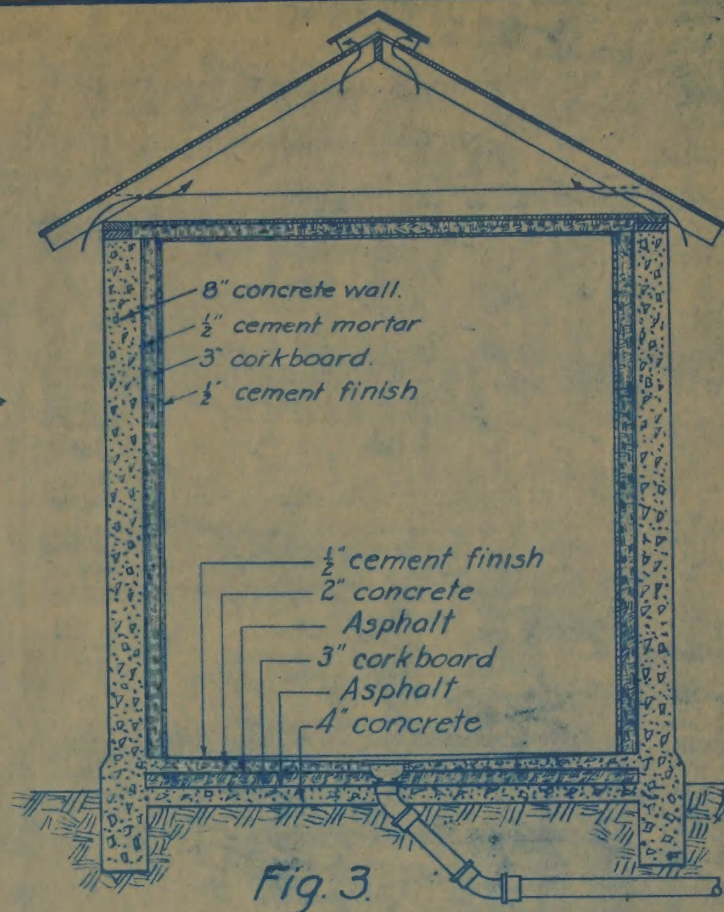
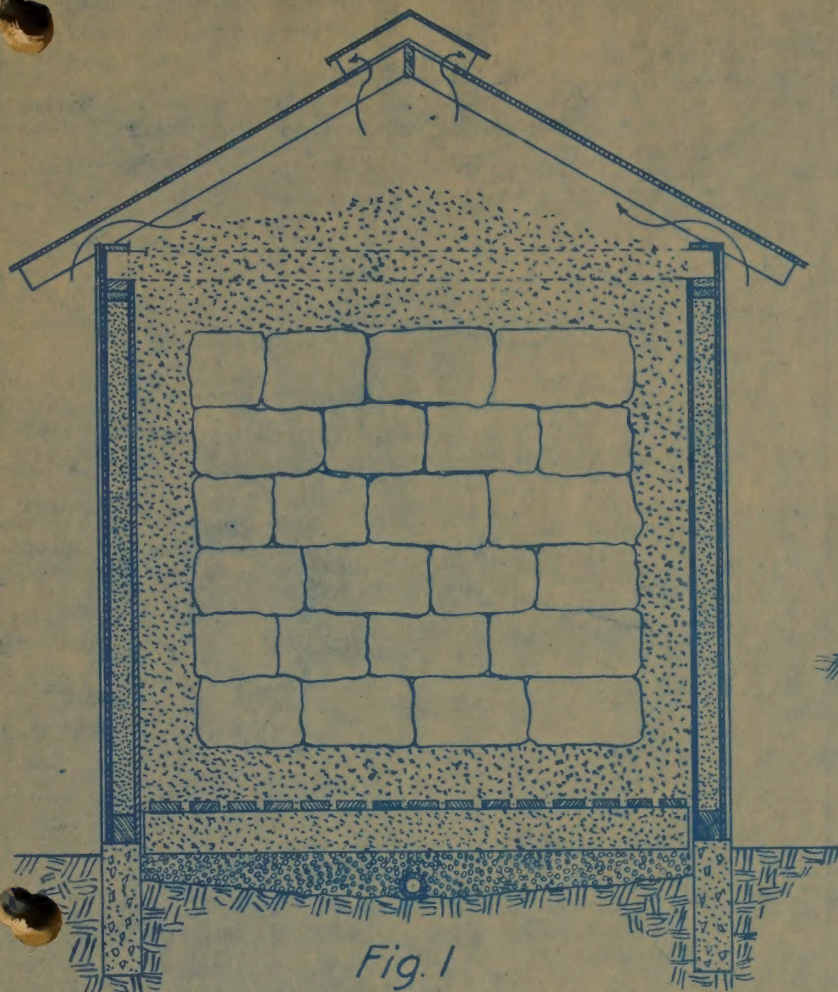
Drain.

|                                  |          |                     |            |
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DATE Oct. 4 1916

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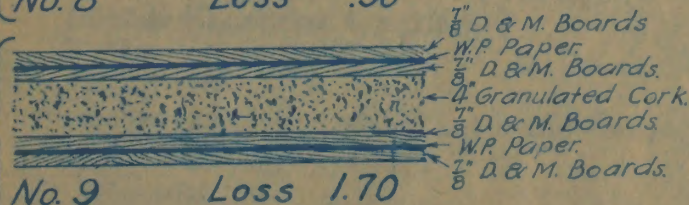
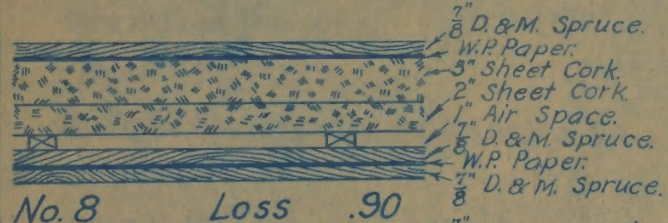
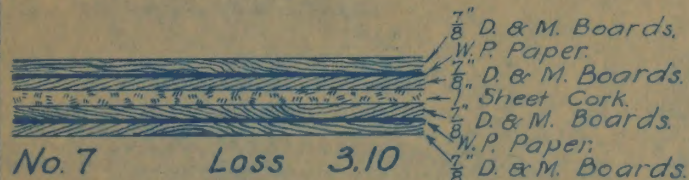
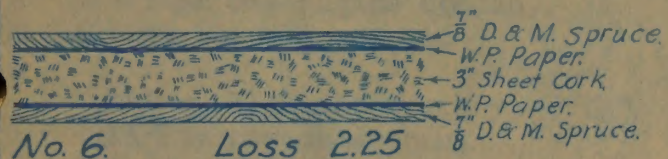
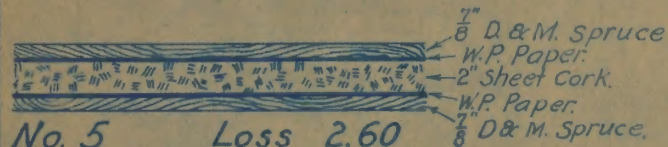
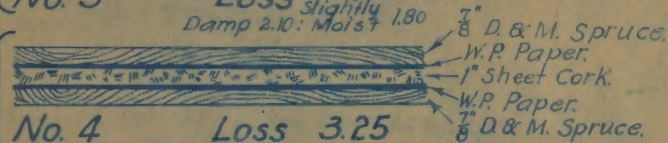
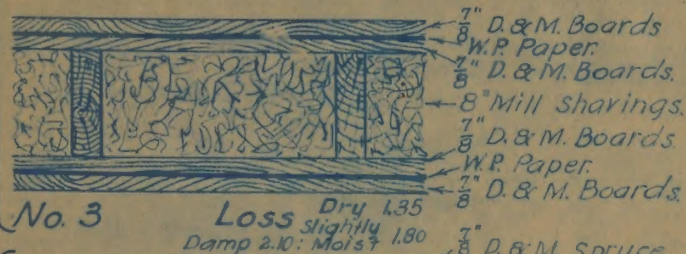
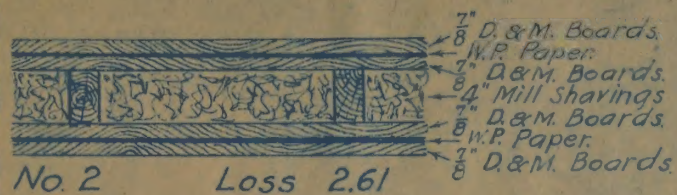
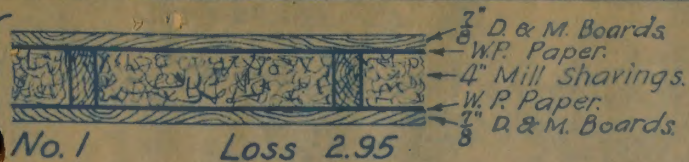
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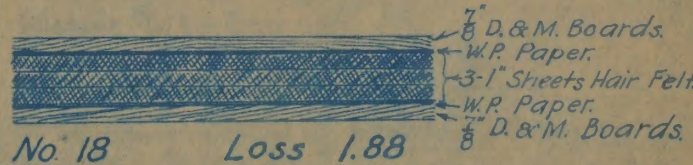
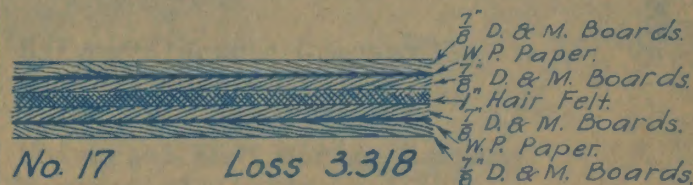
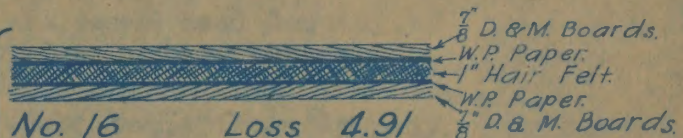
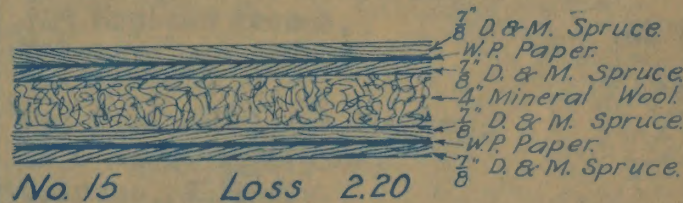
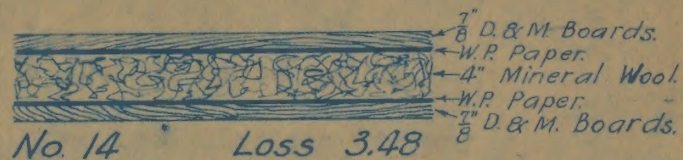
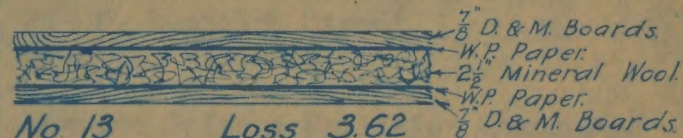
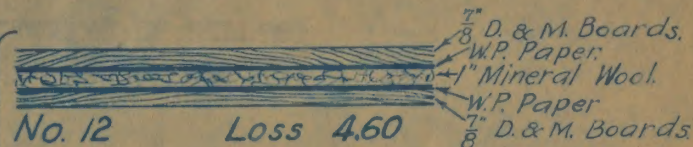
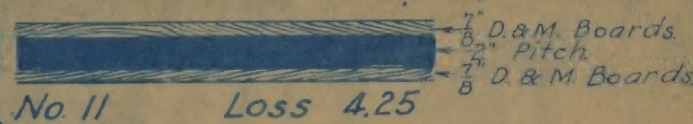
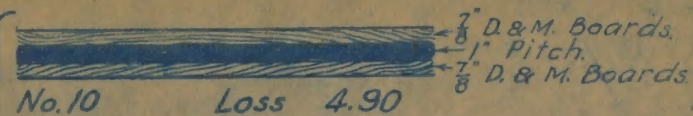




MILL SHAVINGS



PITCH



HAIR FELT

SHEET CORK

GRANULATED CORK

"Loss" represents the number of heat units transmitted per sq. ft. per day for each degree of difference of temperature between the outside and inside air. The above values are not the results of tests conducted by this Department, but are taken from various sources, generally considered authentic. Values not being obtained by the same experimenters are not strictly comparable.

D. & M. means DRESSED & MATCHED.

W.P. means WATER PROOF.

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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
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Information Series No. 37.

March 1920.

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Geneva, New York.

Western Electric Company,  
463 West Street,  
New York City, N. Y.

The Domestic Engineering Company,  
Dayton, Ohio.

Lalley Light Corporation,  
Detroit, Michigan.

The Globe Electric Company,  
Milwaukee, Wisconsin.

Regal Gas Engine Company,  
Pearl & Monroe Streets,  
Coldwater, Michigan.

Atlas Electric Storage Battery Co.,  
Greenville, Michigan.

Automatic Light Company,  
Ludington, Michigan.

Black Swan Company,  
Waseca, Minnesota.

Brunston Electric Lighting & Power Co.,  
New York City, New York.

Dayton Electric Manufacturing Co.,  
Dayton, Ohio.

Winters Farm Light Company,  
Davenport, Iowa.

Frost Engineering Company,  
Oak Park, Illinois.

Morrell Company,  
Toledo, Ohio.

Perfection Storage Battery Company,  
Chicago, Illinois.

Rural Electric Equipment Co.,  
Canton, Pennsylvania.

Gray Motor Company,  
Detroit, Michigan.

Heuricks Magneto & Electric Co.,  
Indianapolis, Indiana.







Lawson-Lawton Company,  
Mepere, Wisconsin.

Universal Products Company,  
Sandusky, Ohio.

Fairfield Engine Company,  
Fairfield, Iowa.

Swartz Electric Company,  
Indianapolis, Indiana.

Unilectric Corporation,  
Detroit, Michigan.

Universal Battery Company,  
Chicago, Illinois.

Watson Electric Company,  
Chicago, Illinois.

Sheldon Engine & Sales Company,  
Waterloo, Iowa.

John Lauson Manufacturing Company,  
New Holstein, Wisconsin.

Roth Brothers & Company,  
1410 W. Adams Street,  
Chicago, Illinois.

Schug Electric Manufacturing Company,  
Detroit, Michigan.

The Pierson Telegraph & Gransmitter Company,  
Topeka, Kansas.

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Lambert-Booth & Company,  
Chicago, Illinois.

Western Electric Company,  
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Western Electric Company,  
Chicago, Illinois.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF RURAL ENGINEERING

Information Series No. 38.

June, 1920.

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DOMESTIC REFRIGERATION.

Mechanical refrigeration for cold storage plants requires the services of a skilled engine man whose duties are to start and stop the machines as the necessity arises; to watch the pressure gages; regulate the expansion valves; attend to oiling; and in fact, to give the equipment constant attention.

Mechanical refrigeration for domestic use presents an entirely different problem. A miniature refrigerating plant for use in the home must be strictly automatic, foolproof, and designed to operate without any attention, except occasional oiling. Equipment that would meet these requirements was in the experimental stage for a number of years, each year bringing nearer realization a machine that a manufacturer could offer to the public and give with it a positive guarantee that it will operate satisfactorily.

Refrigerating Medium.

Liquid ammonia and liquid carbon dioxide are used in large plants as the refrigerating agent or medium by which heat is abstracted and lower temperatures maintained. Ammonia in the gaseous form requires a normal pressure of 175 to 200 lb. per sq. inch and carbon dioxide, a pressure of between 800 and 1000 lb. per sq. inch to condense the gas by abstracting its heat and thus reconvert it to the liquid form for repetition of the refrigerating cycle. These pressures proved impracticable for small domestic machines. The lower pressure under which ethyl chloride and sulphur dioxide may be converted from the gaseous



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF RURAL ENGINEERING  
DIVISION OF RURAL ENGINEERING

June, 1920.

Information Series No. 58.

MECHANICAL REFRIGERATION.

Mechanical refrigeration for cold storage plants requires the services of a skilled engine man whose duties are to start and stop the machines as the necessary valves; to watch the pressure gauges; regulate the expansion valves; attend to oiling; and in fact, to give the equipment constant attention.

Mechanical refrigeration for domestic use presents an entirely different problem. A miniature refrigerating plant for use in the home must be strictly automatic, foolproof, and designed to operate without any attention, except occasional oiling. Equipment that would need these requirements was in the experimental stage for a number of years, each year bringing nearer realization a machine that a manufacturer could offer to the public and give with it a positive guarantee that it will operate satisfactorily.

Refrigerating Media.

Fixed ammonia and liquid carbon dioxide are used in large plants as the refrigerating agent or medium by which heat is absorbed and lower temperatures maintained. Ammonia in the gaseous form requires a normal pressure of 115 to 130 lb. per sq. inch and carbon dioxide a pressure of between 500 and 1000 lb. per sq. inch to condense the gas by absorbing its heat and then reevaporating it to the liquid form for repetition of the refrigerating cycle. These pressures proved impracticable for small domestic machines. The lower pressure under which ethyl chloride and sulfur dioxide may be converted from the gaseous



-2-

to the liquid state offered the solution. Sulphur dioxide is the refrigerant which is now employed almost exclusively in the domestic refrigerating machines on the market. Its pressure in the condenser rarely exceeds 75 lb. per sq. inch and is usually lower.

#### Application of the Domestic Refrigerating Machine.

Domestic refrigerating apparatus is designed to maintain a lower and more uniform temperature in the average size ice box or refrigerator, than can be obtained with ice, and at the same time keep the air dry. The machines are built for installation in any well constructed standard type ice box. A brine tank, and with some makes of machines, a copper pipe coil, is placed in the compartment of the box which is ordinarily filled with ice. The brine tank is filled with a solution of calcium chloride, in which the expansion coils are immersed. In each brine tank a small ice-making chamber is fitted in which very small cubes of ice for table use may be made. The machines do not have the capacity to make large quantities.

#### Operation.

The compressor, driven by an electric motor usually of  $1\frac{1}{4}$  horsepower, and the condenser are generally placed in the basement (to save space in the kitchen). Copper tubing connects the compressor with the brine tank in the box. A thermostat actuated by the temperature existing inside the refrigerator, automatically starts and stops the motor. The thermostat is sensitive to a temperature difference of about 4 or 5 degrees so that when the motor stops, the thermostat permits the temperature inside the box to vary this amount before it causes the motor to start again. The brine in the tank is always at a temperature between 20 and 25 degrees F. The air inside the box directly in contact



as the liquid state of the solution. But this is the  
refrigerant which is now employed almost exclusively in the domestic  
refrigerating machines on the market. Its pressure in the condenser  
rarely exceeds 15 lb. per sq. inch and is usually lower.

#### Analysis of the Domestic Refrigeration Machine.

Domestic refrigerating machines are designed to maintain a  
lower and more uniform temperature in the storage area than in  
refrigerator. They can be obtained with ice, and at the same time keep  
the air dry. The machines are built for installation in any well con-  
structed standard type box. A brine tank, and with some cases of  
machines, a copper pipe coil, is placed in the compartment of the box  
which is ordinarily filled with ice. The brine tank is filled with a  
solution of calcium chloride, in which the expansion coils are immersed.  
In each brine tank a small ice-making chamber is fitted in which very  
small cubes of ice for table use may be made. The machines do not have  
the capacity to make large quantities.

#### Operation.

The compressor, driven by an electric motor, is generally of 1/4  
horsepower, and the condenser are generally placed in the basement (as  
was shown in the kitchen). Copper tubing connects the compressor with  
the brine tank in the box. A thermostat actuated by the temperature  
existing inside the refrigerator, automatically starts and stops the  
motor. The thermostat is sensitive to a temperature difference of about  
1 or 2 degrees so that when the motor stops, the thermostat permits the  
temperature inside the box to vary this amount before it causes the  
motor to start again. The brine in the tank is always at a temperature  
between 20 and 25 degrees F. The air inside the box directly in contact



with the brine tank is constantly cooled and this maintains a continuous circulation of air within the box. It is also dried by depositing its moisture, in the form of a frost, on the brine tank, as it circulates and it comes into contact with the tank. This assures dry air passing over the contents of the box which is essential for the best refrigerating effect.

The total number of hours that a machine will be in operation during the twenty-four is governed by the size of the ice-box, the quality and condition of the box, the room temperature and the number of times that the box door is opened. Average conditions may be assumed to require about eight hours operation in twenty four.

#### Retail Prices.

Prices will be found to vary for different machines and for the same machine at different times due to differences in the cost of labor and material. The following prices are rough approximations and while they may apply at this time to one manufacturers' product, they do not by any means apply to all nor should it be understood that they will be the same six months hence (1921).

| Maximum cubical Contents of Refrigerator<br>to which Machine is suitable. | Approximate Retail Price |
|---------------------------------------------------------------------------|--------------------------|
| Cubic Feet                                                                | Dollars                  |
| 20                                                                        | \$350                    |
| 30                                                                        | 400                      |
| 40                                                                        | 450                      |

To the above prices should be added an amount to cover the labor and material necessary for the installation. This will generally range from \$10.00, up depending upon conditions.

#### Cost of Operation.

On the basis of a 1/4 horsepower motor, which is the size commonly used, consuming about 300 watts of electrical energy in driving



with the brine tank is constantly cooled and this maintains a continuous circulation of air within the box. It is also aided by depositing the moisture, in the form of a frost, on the brine tank, with circulation and it comes into contact with the tank. This causes dry air passing over the contents of the box which is essential for the best refrigerating effect. The total weight of brine used in a machine will be in operation during the twenty-four hours in proportion to the size of the box and the weight of the brine, the weight of the brine, the weight of the brine, and the weight of the brine. That the box does not become too warm. Average conditions may be assumed to be about eight hours operation in twenty four.

### Boxing Prices.

Prices will be found to vary for different machines and for in some machines at different times due to differences in the cost of labor and material. The following prices are rough approximations and while they may apply at this time to one manufacturer's product, they do not apply to any other as all are subject to be understood that they will be the same six months hence (1931).

| Approximate Retail Prices | Maximum output capacity of Refrigerator to which machine is attached |
|---------------------------|----------------------------------------------------------------------|
| Boxing                    | Boxing                                                               |
| \$150                     | 50                                                                   |
| \$200                     | 75                                                                   |
| \$250                     | 100                                                                  |

To the above prices should be added an amount to cover the labor and material necessary for the installation. This will generally range from \$10.00 up depending upon conditions.

### Cost of Operation.

On the basis of a 1 1/2 horsepower motor, which is the size commonly used, consuming about 300 watts of electrical energy in running



the compressor, and assuming that the machine will be in operation about one-third of the time, the monthly current consumption would amount to approximately 300 (watts per hour) x 8 (hours in operation per day) x 30 (days in a month) = 72,000 watts or 72 kw-hrs. Multiplying this by the rate per kilowatt hour, the cost per month is determined as given below.

Monthly Operating Cost at Different Rates.

| <u>Rate per</u><br><u>KW-hr.</u> | <u>Cost of</u><br><u>Operation per Month</u> |
|----------------------------------|----------------------------------------------|
| \$ .03                           | 2.16                                         |
| .0325                            | 2.34                                         |
| .04                              | 2.88                                         |
| .05                              | 3.60                                         |
| .06                              | 4.32                                         |
| .07                              | 5.04                                         |
| .08                              | 5.76                                         |
| .09                              | 6.48                                         |
| .10                              | 7.20                                         |

The average cooking rate for electric current throughout the United States is \$0.0325 per kilowatt hour. It very properly may be assumed that it will earn the same rate as the electric range owing to the comparative high load factor of the refrigerating apparatus. On this basis the cost of operation per month would be \$2.34 which compares very favorably with the monthly ice bill for delivery. When the purchase price and interest on the investment are considered, replacement of the ice man by domestic refrigerating apparatus becomes an individual question as to whether it can be afforded.







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 39.

December, 1920.

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USE OF ALCOHOL AS A MOTOR FUEL

At the present time this Department has no publications on this subject available for free distribution. Most of the work that has been done in this country concerning the use of alcohol as an internal combustion engine fuel was carried on principally between 1905 and 1907. At that time a series of experiments were conducted in the mechanical laboratory of Columbia University in which a representative of this Department cooperated.

The conclusions drawn from the results of these experiments and from the results of European experiment and investigations conducted at about the same time follow:

- (1) Any engine on the American market today, operating with gasoline or kerosene, can operate with alcohol fuel without any structural change whatever with proper manipulation.
- (2) Alcohol contains approximately 0.6 of the heating value of gasoline, by weight, and in the Department's experiments a small engine required 1.8 times as much alcohol as gasoline per horsepower hour. This corresponds very closely with the relative heating value of the fuels, indicating practically the same thermal efficiency with the two when vaporization is complete.
- (3) In some cases carbureters designed for gasoline do not vaporize all the alcohol supplied, and in such cases the excess of alcohol consumed is greater than indicated above.
- (4) The absolute excess of alcohol consumed over gasoline or kerosene will be reduced by such changes as will increase the thermal efficiency of the engine.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Washington, D.C.  
December 1, 1920

Information Series No. 32

USE OF ALCOHOL AS A FUEL

As the present state of knowledge has no publications on this subject available for the Bureau of Public Roads, it has been deemed in this country concerning the use of alcohol as an internal combustion engine fuel was carried on principally between 1907 and 1917. At this time a series of experiments were conducted in the mechanical laboratory of Columbia University in which the results of these experiments were published.

From the results of these experiments and investigations conducted at about the same time the following conclusions were reached:

- (1) Any engine on the market today, operating with alcohol or kerosene, can operate with alcohol fuel with not any essential change in the design of the engine.
- (2) Alcohol contains about 70% of the heat value of gasoline by weight, and in the laboratory experiments a small engine designed for use with alcohol fuel gave a heat output of 1.5 times as much as when it was run on kerosene. This corresponds very closely with the relative heating value of the fuels, indicating that the engine efficiency was about the same when operated on either fuel.
- (3) In some cases carburetors designed for gasoline do not operate with the alcohol fuel, and in such cases the carburetor of alcohol engines is of a different design.
- (4) The absolute excess of alcohol consumed over gasoline or kerosene will be reduced by such changes as will increase the thermal efficiency of the engine.



- (5) The thermal efficiency of these engines can be improved when they are to be operated by alcohol, first by altering the construction of the carbureter to accomplish complete vaporization, and second, by increasing the compression very materially.
- (6) An engine designed for gasoline or kerosene can, without any material alterations to adapt it to alcohol, give slightly more power (about 10 per cent) than when operated with gasoline or kerosene, but this increase is at the expense of greater consumption of fuel. By alterations designed to adapt the engine to new fuel this excess of power may be increased to about 20 per cent.
- (7) Because of the increased output without corresponding increase in size, alcohol engines should sell for less per horsepower than gasoline or kerosene engines of the same class.
- (8) The different designs of gasoline or kerosene engines are not equally well adapted to the burning of alcohol, though all may burn it with a fair degree of success.
- (9) Storage of alcohol and its use in engines is much less dangerous than that of gasoline, as well as being decidedly more pleasant.
- (10) The exhaust from an alcohol engine is less likely to be offensive than the exhaust from a gasoline or kerosene engine, although there will be some odor, due to lubricating oil and imperfect combustion, if the engine is not skillfully operated.
- (11) It requires no more skill to operate an alcohol engine than one intended for gasoline or kerosene.
- (12) There is no reason to suppose that the cost of repairs and lubrication will be any greater for an alcohol engine than one for built for gasoline or kerosene.
- (13) There seems to be no tendency for the interior of an alcohol engine to become sooty, as is the case with gasoline and kerosene.
- (14) With proper manipulation, there seems to be no undue corrosion of the interior due to the use of alcohol.



- (5) The thermal efficiency of these engines can be improved when they are to be operated by alcohol, first by altering the construction of the combustion chamber and second, by increasing the compression ratio.
- (6) The thermal efficiency of these engines can be improved by altering the construction of the combustion chamber and second, by increasing the compression ratio.
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- (14) The thermal efficiency of these engines can be improved by altering the construction of the combustion chamber and second, by increasing the compression ratio.
- (15) The thermal efficiency of these engines can be improved by altering the construction of the combustion chamber and second, by increasing the compression ratio.



- (15) The fact that the exhaust from the alcohol engine is not as hot as that from gasoline and kerosene engines seems to indicate that there will be less danger from fire, less offense in a room traversed by the exhaust pipe, and less possibility of burning the lubricating oil. This latter point is also borne out by the fact that the exhaust shows less smokiness.
- (16) In localities where there is a supply of cheap raw material for the manufacture of denatured alcohol, and which are at the same time remote from the source of supply of gasoline, alcohol may immediately compete with gasoline as a fuel for engines.
- (17) If, as time goes on, kerosene and its distillates become scarcer and dearer by reason of exhaustion of natural deposits, the alcohol engine will become a stronger and stronger competitor, with a possibility that in time it may entirely supplant the kerosene and gasoline engines.
- (18) By reason of its greater safety and its adaptability to the work, alcohol should immediately supplant gasoline for use in boats.
- (19) By reason of cleanliness in handling the fuel, increased safety in fuel storage, and less offensiveness in the exhaust, alcohol engines will, in part, displace gasoline engines for automobile work, but only when cost of fuel for operation is a subordinate consideration. In this field it is impossible to conveniently increase the compression because of starting difficulties, so that the efficiency can not be improved as conveniently as in other types of engines.
- (20) In most localities it is unlikely that alcohol power will be cheaper or as cheap as gasoline power for some time to come.







REFERENCES TO EXPERIMENTS AND DATA  
RELATING TO THE USE OF ALCOHOL  
AS A MOTOR FUEL.

Tests of Internal Combustion Engines on Alcohol Fuel. Office of Experiment Stations Bulletin No. 191, U. S. Department of Agriculture. Procurable only from the Superintendent of Documents, Government Printing Office, Washington, D. C. at 20¢ per copy. Stamps not accepted in payment.

The Use of Alcohol and Gasoline in Farm Engines, Farmers' Bulletin No. 277, U. S. Department of Agriculture. Procurable only from the Superintendent of Documents at 5¢ per copy. Stamps not accepted in payment. Gasoline and Alcohol Tests on Internal Combustion Engines. Bureau of Mines Bulletin No. 32, Department of Interior. (This Bulletin is out of print but you may be able to find it in some of the libraries).

Substitute for Gasoline in Engines (Describes and discusses tests using kerosene and alcohol). Pennsylvania State College, Engineering Series Bulletin, Vol. 1, No. 3, State College of Pennsylvania.

The Automobile Fuel Situation (Discusses some possibilities of other fuels as methods of relief from the high cost of gasoline.) Society of Automobile Engineers Bulletin, March, 1916.

Data on Mixed Motor Fuels (Discusses driving tests with benzol and benzol-alcohol mixture). The Automobile, October 14, 1915.

Substitute fuels for Motors (Discusses the possibility of relief through alcohol and some problems in using kerosene). Motor Age, March 23, 1915.

Alcohol the Fuel of the Future. Automobile, November 30, 1916.

Three New Sources of Fuel Alcohol Processes for the production of alcohol from molasses, wood waste, and acetylene described in technical appendices to a German-War-time law creating an alcohol monopoly. Commercial prospects of the processes discussed. Automotive Industries, January 8, 1920, Page 80.

Review Technique, December 10, 1903, discusses alcohol as a source of motive power; discusses the availability of alcohol for use in internal combustion motors showing its high efficiency.







Gener Civil, June 29, 1901, "The Use of Alcohol in Motors for Automobiles", gives a tabulated review of the performance of thirty different kinds of vehicles using alcohol in internal combustion motors.

Scientific American, Supplement, January 25, 1902, "Alcohol and Automobiles", discusses recent tests of this fluid in the neighborhood of Paris.

Auto Journal, February, 1902, "The Problem of Alcohol", discusses the applicability of alcohol to the operation of explosive engines and the experiments made in France and other places.

American Journalist, Volume 27, No. 41, "Alcohol for Motors", discusses the causes that have led to the use of alcohol in Europe and also the merits of alcohol as a fuel.

Engineering, January 10, 1902, "French Spirit Motors", An account of the steps being taken in France and Germany in using alcohol for driving motors. Discusses also the construction of motors.

Engineering Magazine, February, 1904, "Mechanical and Commercial Aspect of the Alcohol Motor", gives numerous illustrations showing the use of alcohol in internal combustion motors, data, and results of tests.

The Automobile, June 15, 1905, "Alcohol as a Fuel for Motors", discusses the heat required for vaporization, etc.

The Engineer, London, November 8, 1901, "Alcohol Motor Car Trails in France", a description of the trails under the auspices of the Minister of Agriculture.

The Engineer, London, June 5, 1903, "French Research on Alcohol Motors," considers the fuel employed, effects of the fuel on the motor, analysis of the exhaust gases, quantity of air required for combustion and carburation.

Iron Age, October 22, 1903, "Use of Alcohol Engines in Europe", remarks on the interest shown in these engines and on some of the recent types.

Auto Car, January 14, 1905. "Alcohol as a Fuel for Motor Cars", and interview with Dr. Ormandy, discussing why alcohol is not more generally used, its advantages, the working of the alcohol engines, etc.



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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING.

Information Series No. 40.

January 1921.

USE OF A DRAFT GAGE FOR MEASURING DRAFT IN A RESIDENCE CHIMNEY.

If a reliable test of the draft in a chimney is desired, a draft gage should be used. The accompanying illustration shows a gage that may be made by heating a piece of glass tubing about  $1/2$  in. in diameter, and bending it to the shape shown. Fit a piece of wood between the legs of the gage and mark on the wood a scale divided in inches and tenths of an inch.

To measure the draft, partially fill the U-shaped part of the tube with water and insert the end of it into an opening in the flue as shown on blue print. The suction caused by the ascending hot gases will raise the water in the side of the tube next to the chimney and lower it a corresponding amount on the opposite side. Read the difference in height (on the illustration, the difference is shown to be  $1/2$  inch) and compare this difference with that given in the table opposite the height corresponding to that of the chimney being tested. The figures given in the table are for three different temperatures of outgoing gases. The draft as measured should approximate these values. The temperatures shown in the table are those which usually exist near where the draft gage is installed, just about where the smoke pipe enters the flue.

When a chimney flue is tested, two important conditions should be borne in mind; (1) that a new green chimney quickly absorbs the heat of the ascending gases owing to the large amount of moisture in the walls and therefore the draft will not be as strong as when the flue is thoroughly dried out; (2) that the greatest work a chimney has to perform is immediately after a fresh charge of fuel has been added to the fire. In either case the area and height should be sufficient to care for these requirements. But above



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
WASHINGTON, D. C.  
January 1913

Information Circular No. 20

January 1913

THE PROBLEM OF THE PLANT INDUSTRY

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I. S. 40.

all, it should be understood that while a chimney carries off the products of combustion, its real function is to provide a draft of sufficient intensity to burn the fuel with efficiency.

Residence Chimney Drafts.

| Height of chimney. | Temperature of Flue Gases F°      |      |      |
|--------------------|-----------------------------------|------|------|
|                    | 200                               | 250  | 300  |
| Feet.              | Draft-pressure - Inches of Water. |      |      |
| 60                 | 0.27                              | 0.32 | 0.35 |
| 55                 | 0.25                              | 0.29 | 0.32 |
| 50                 | 0.23                              | 0.26 | 0.29 |
| 45                 | 0.21                              | 0.23 | 0.26 |
| 40                 | 0.18                              | 0.21 | 0.23 |
| 35                 | 0.16                              | 0.19 | 0.20 |
| 30                 | 0.14                              | 0.16 | 0.17 |
| 25                 | 0.12                              | 0.14 | 0.14 |
| 20                 | 0.09                              | 0.11 | 0.12 |



1911, 1912, 1913

The following table shows the results of the experiments conducted during the years 1911, 1912, and 1913.

The results of the experiments are given in the following table, which shows the results of the experiments conducted during the years 1911, 1912, and 1913.

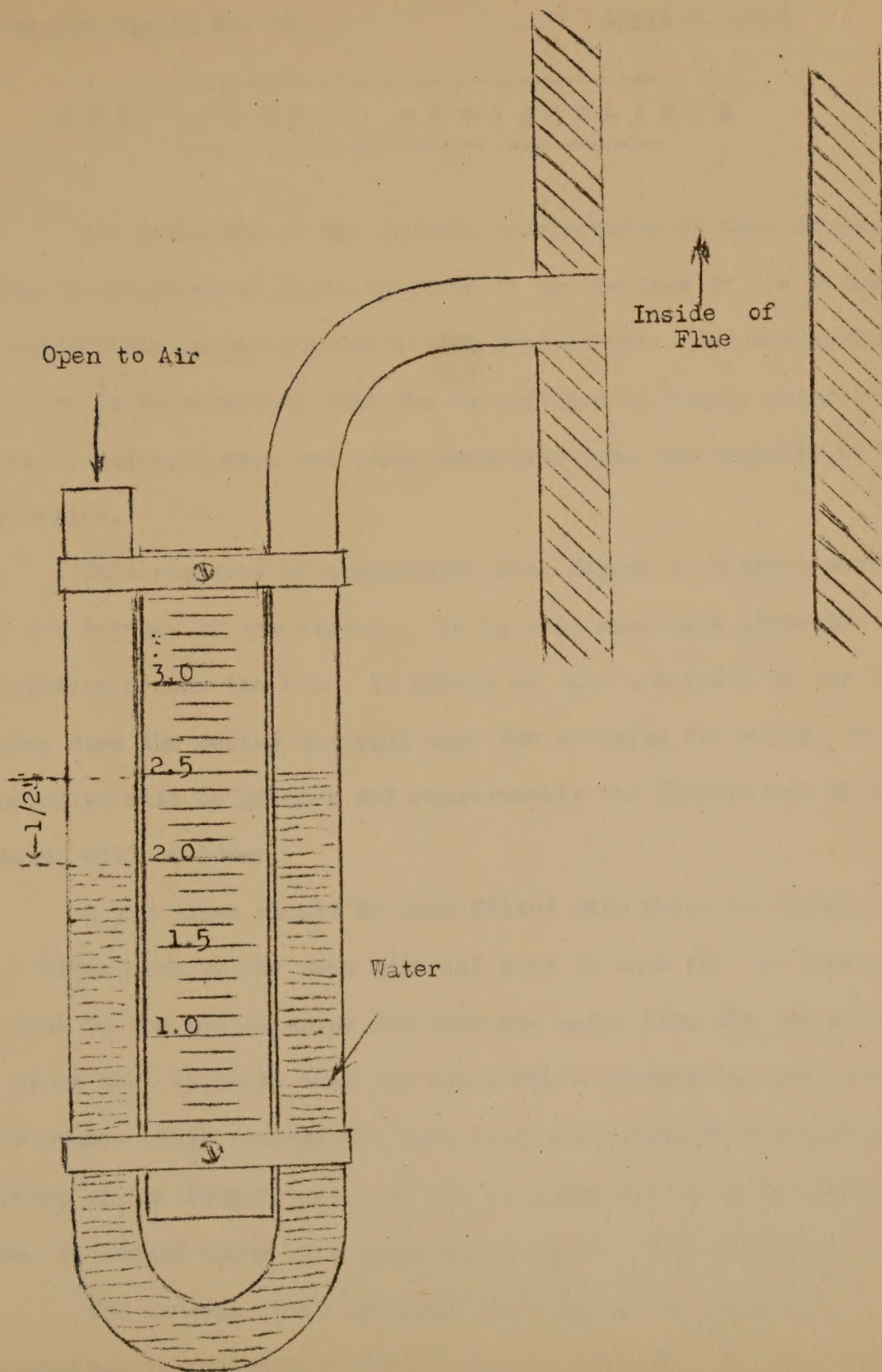
The results of the experiments are given in the following table, which shows the results of the experiments conducted during the years 1911, 1912, and 1913.

Table showing the results of the experiments conducted during the years 1911, 1912, and 1913.

| Year | No. of plants | No. of leaves | No. of flowers | No. of fruits |
|------|---------------|---------------|----------------|---------------|
|      |               |               |                |               |
| 1911 | 100           | 1000          | 100            | 100           |
| 1912 | 100           | 1000          | 100            | 100           |
| 1913 | 100           | 1000          | 100            | 100           |
| 1914 | 100           | 1000          | 100            | 100           |
| 1915 | 100           | 1000          | 100            | 100           |
| 1916 | 100           | 1000          | 100            | 100           |
| 1917 | 100           | 1000          | 100            | 100           |
| 1918 | 100           | 1000          | 100            | 100           |
| 1919 | 100           | 1000          | 100            | 100           |
| 1920 | 100           | 1000          | 100            | 100           |

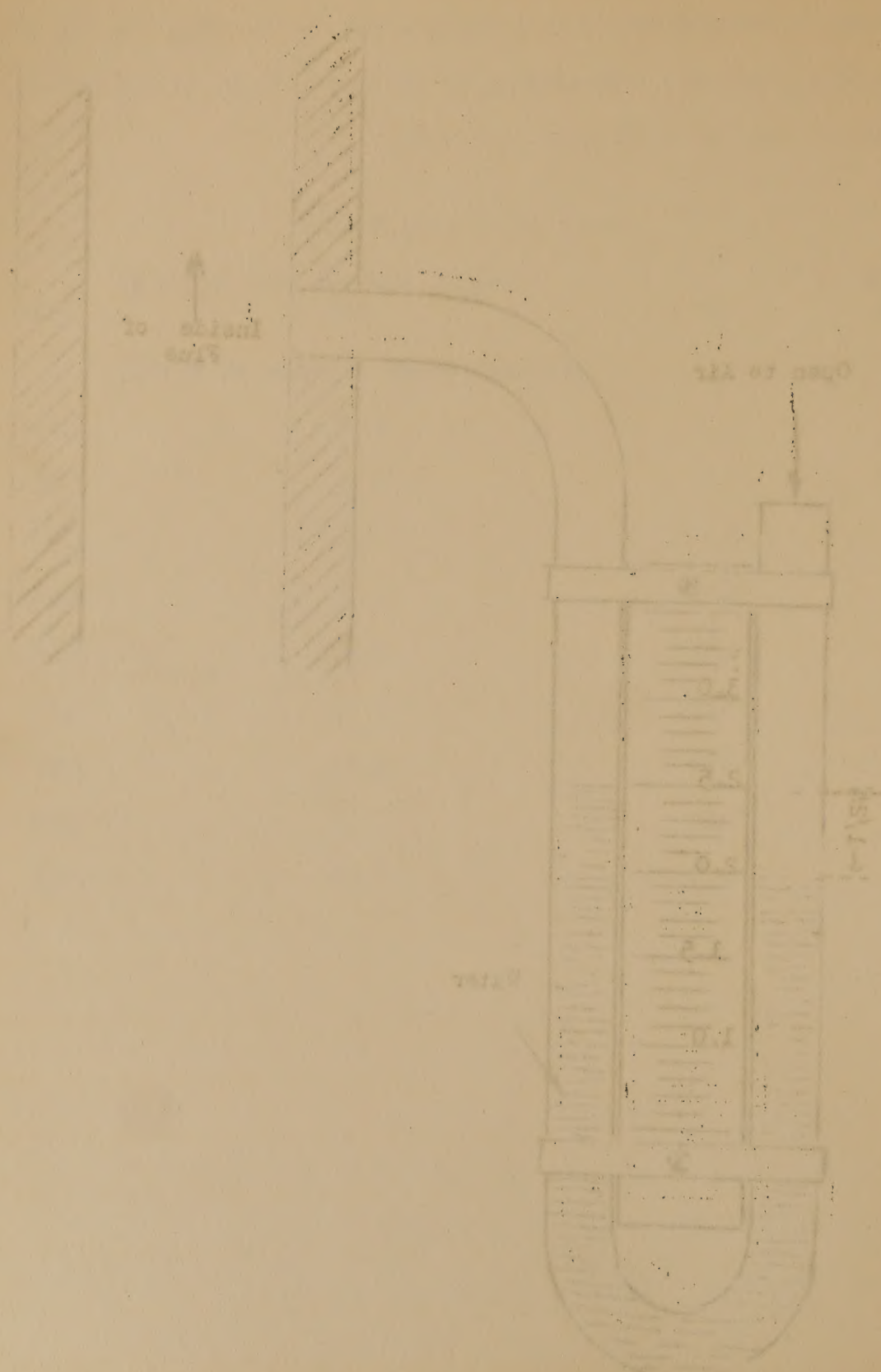


Draft Intensity in Inches of Water



U TUBE DRAFT GAUGE





... to be used in the following manner



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 41.

April 4, 1918.

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THE ICELESS REFRIGERATOR  
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The principle of the iceless refrigerator is that of employing the evaporation of water in place of the melting of ice to lower the temperature inside a properly constructed box. For successful operation it is essential that the evaporation be fairly rapid, the degree of coldness attained being dependent upon the rapidity of the evaporation.

This rapidity of evaporation will depend to a great extent, upon the dryness of the climate. It is also dependent upon air circulation around the box. If placed so that a current of air circulates over the wetted material used for covering the sides, the evaporation will be greater and consequently the temperature in the interior will be lower.

A pan which should be kept filled with water is placed on the top. Wicks made of the same material that is used for the side covering rest in the pan of water and draw the water from the pan distributing it so that it seeps down the sides where evaporation continually takes place. This removes the heat from the inside with a consequent lowering of the temperature. If the refrigerator is to be used indoors, it should stand in a large pan so as to catch the drip.

The success to be obtained from the use of this type of refrigerator is affected by the climatic conditions existing in the locality in which it is to be used. In the arid and semi-arid sections of our country it usually works particularly well.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
DIVISION OF ENTOMOLOGICAL RESEARCH

April 1, 1912.

Information Series No. 11.

THE TEMPERATURE OF THE AIR

The principle of the method of observation is that of measuring the temperature of the air in the vicinity of the insect. The temperature inside a properly constructed box, for example, is measured. It is essential that the observation be fairly rapid, the degree of condensation retained being dependent upon the rapidity of the observation.

This rapidity of observation will depend to a great extent upon the degree of the climate. It is also dependent upon the observation around the box. It is placed so that a current of air circulates over the wetted material and the covering the sides. The observation will be greater and consequently the temperature in the interior will be lower.

A box which should be kept filled with water is placed on the top. While inside of the box material that is used for the side covering is placed in the box of water and draw the water from the box. It is so that it keeps down the sides where evaporation continually takes place. This removes the heat from the inside with a consequent lowering of the temperature. If the refrigerator is to be used indoors, it should stand in a large pan so as to catch the drip. The reason for this is that the use of this type of refrigerator is affected by the climatic conditions existing in the locality in which it is to be used. In the mild and temperate zone of our country it usually works particularly well.



The accompanying blueprint may be used as a guide by one who intends to construct an iceless refrigerator. The dimensions may be changed to suit requirements. While it is not necessary that the frame be screened, it is highly desirable. The wooden frame is covered with burlap, cotton flannel, or some similar material. This material should be tacked to the inside of the top and bottom frames but not to the shelves or cleats supporting them, except that at the bottom it should be attached to the underside of the shelf so as to close the passage.

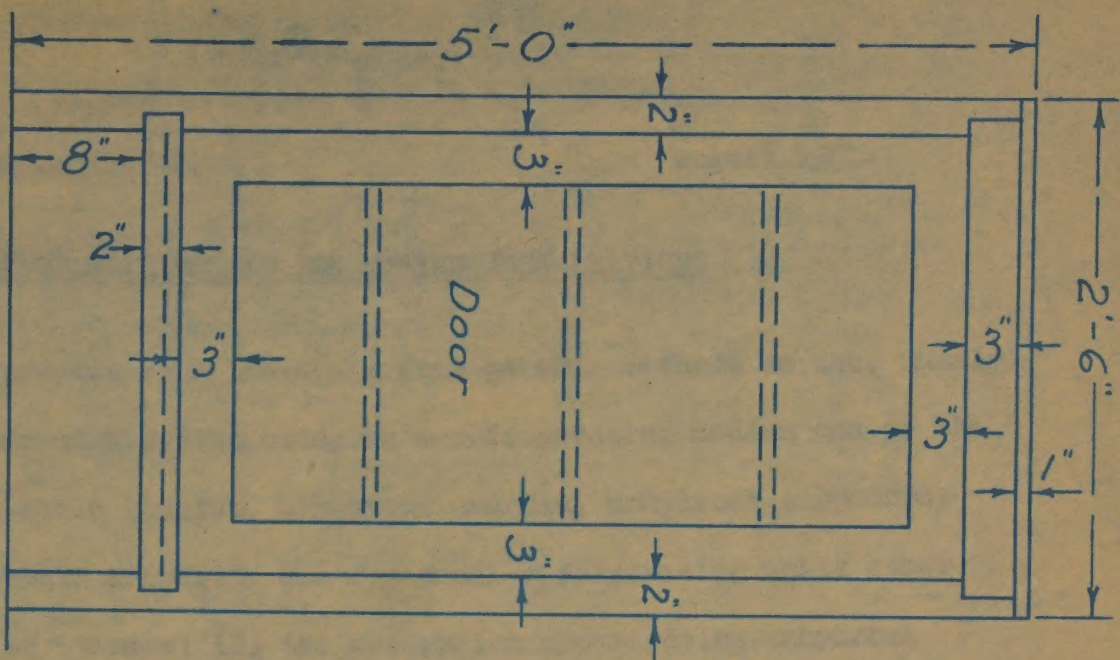
A solid top is shown on the blueprint, but if desired the pan on top may be made to fit closely into the opening of the top frame and may be supported by 1 inch cleats fastened to the inside of the frame. The shelves should be removable to facilitate cleaning.

The refrigerator should be placed in a shady place where air may circulate freely around it. The burlap should be well wetted down all round, but not so as to drip.

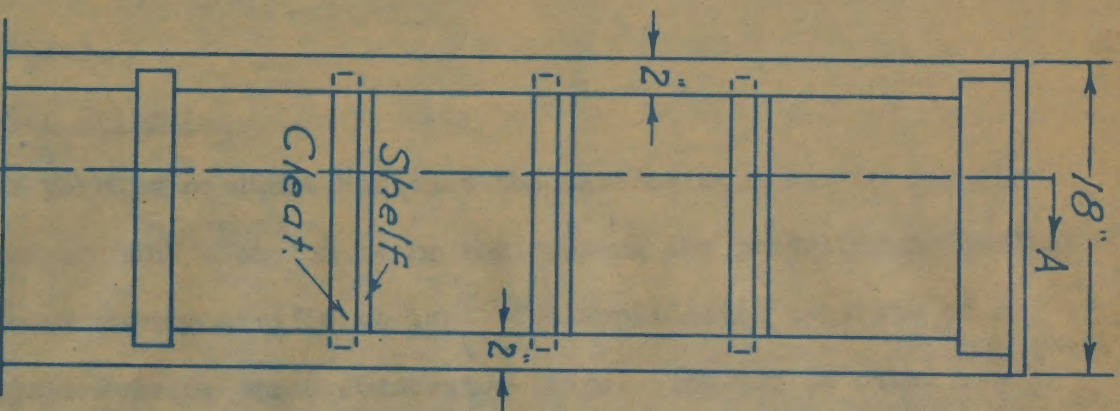




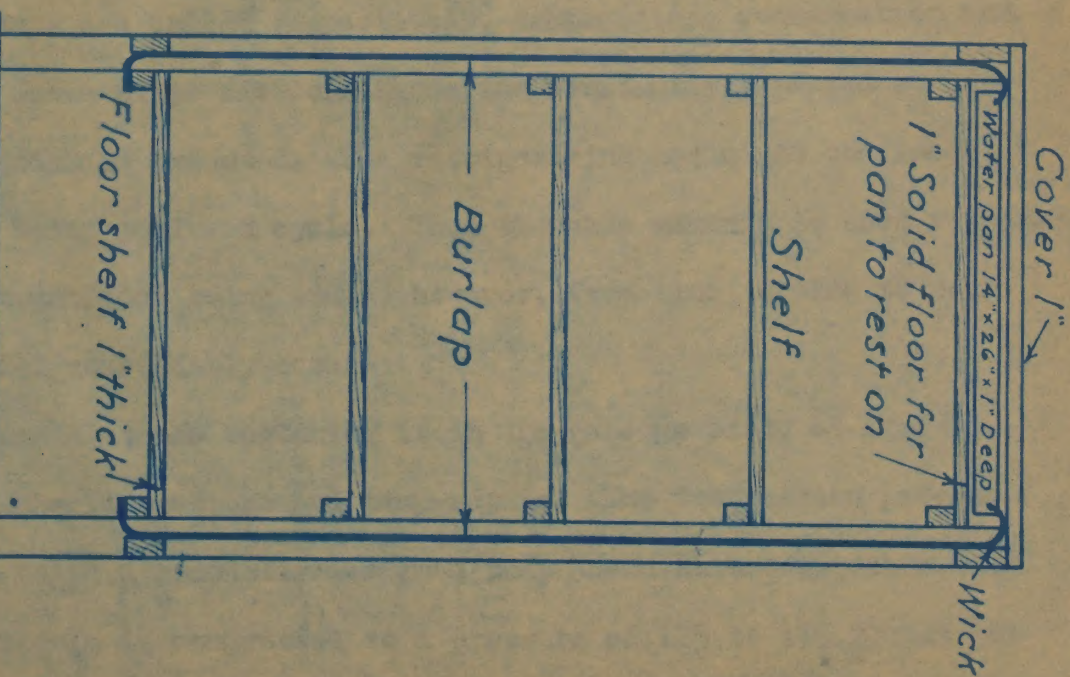




Front



Side



Section A-B

Note:-

This refrigerator is designed for use in locations where climatic conditions render high evaporation possible during portions of the year.

It is not recommended as a substitute for an ice refrigerator where ice is available, but for locations where it is impossible or difficult to procure ice.

To accompany information Series No. 41.

DATE APRIL 7, 1916. FILE

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| U.S. Department of Agriculture     |                     |
| Office of                          |                     |
| PUBLIC ROADS and RURAL ENGINEERING |                     |
| Division of                        |                     |
| RURAL ENGINEERING                  |                     |
| ICELESS REFRIGERATOR               |                     |
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| DESIGNED BY DANIELS                | MADE                |
| TESTED BY A. H. H. H. H.           | MADE                |
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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 42.

August 1921.

REFRIGERATION AND ICE MAKING INSTALLATIONS

At the present time there are four general methods in use, namely:

- (1) the compression system using as a refrigerating medium one of the following volatile liquids, anhydrous ammonia, anhydrous sulphurous dioxide, carbonic anhydride and for small refrigerating units other less common substances;
- (2) the absorption system using anhydrous ammonia;
- (3) cold air compression system using air;
- (4) vacuum machine using water vapor.

The Compression System:

There is perhaps no doubt but that the ammonia compression system occupies a pre-eminent position among the systems for producing mechanical refrigeration or making artificial ice. Its application consists of a complete cycle involving three successive steps. The use of other refrigerating mediums does not alter the process in essential details. The three steps are called respectively, compression, condensation and expansion. These steps are continuous and constantly repeated so long as refrigeration is produced. The refrigerating medium is confined, the process being a closed cycle. Thus the same ammonia is used repeatedly additional quantities being added, however, from time to time to make up losses that unavoidably occur.

The ammonia at the beginning is in the gaseous state at approximately atmospheric pressure and temperature. The compression process consists in using a specially designed pump known as a compressor with which the ammonia is compressed to a pressure of 125 to 175 pounds per square inch. Before being compressed the ammonia like all bodies contains







a certain quantity of heat. After being compressed it contains practically the same amount which is sufficient even at the increased pressure to maintain the ammonia in the gaseous state in which condition it leaves the compressor at the end of the compression process.

The condensation process consists in removing the excess heat of the gas for the pressure at which it leaves the compressor. A condenser is used for this purpose. It consists of a series of pipes arranged so that a stream or streams of cold water pass over them and abstract the excess heat from the ammonia within. This extraction of heat causes the ammonia gas to liquify in which condition it leaves the condenser.

The expansion process is that in which the refrigeration is produced. The refrigerator consists usually of a net-work of pipes arranged as may be desired. The liquid ammonia is admitted into these pipes through a special valve known as the expansion valve. This valve is generally set so as to permit only enough liquid ammonia to pass to maintain a pressure of about 25 to 55 pounds per square inch in the refrigerator pipes. This ammonia being reduced in pressure passes again into the gaseous state and the gas thus formed is reduced in temperature considerably below the freezing point of water. Therefore, it is in a condition to absorb heat from the pipe system and thus reduces the temperature of the compartment in which the refrigerator pipes are installed. The compressor draws its supply of ammonia from the refrigerator pipes and the cycle is repeated.

#### The Absorption System:

The principle involved in this system of refrigeration is the absorption of ammonia gas or anhydrous ammonia by water. Aqua ammonia or what is generally known as ordinary ammonia is the refrigerating medium



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supplied to the circulating system of the apparatus. It consists of water with about ten per cent of ammonia gas in solution. Strong water of ammonia may contain about twenty-eight per cent of gas.

The system consists of a repeating cycle of operations involving four processes; (1) Generation of gas from the ammonia water; (2) Condensation of the gas; (3) Expansion of the gas; and (4) Absorption of the gas.

The generation process consists in pumping the aqua ammonia from iron drums in which it is delivered into the generator. The generator usually consists of a closed tank containing steam coils. The application of the heat from the steam to the aqua ammonia drives off ammonia gas and brings the pressure to between 120 to 160 pounds per square inch at which pressure the gas leaves the generator.

The condensation process is similar to that described for the compression system. The gas passes through pipe coils over which cold water trickles, the gas gives up its heat, and this cooling reduces the gas to a liquid, in which condition it leaves the condenser.

The expansion stage produces the refrigeration in a manner exactly similar to that explained for the compression system, the gas whose temperature has been materially lowered absorbing heat from the pipes.

The absorption process consists in providing a closed tank called an absorber which holds water which has been deprived of the greater part of its ammonia gas in the generator. This is sometimes called "weak liquid." This absorber maintains the low pressure in the refrigerating coils by drawing into it the gas generated in the coils. The "weak liquid" absorbs it to form aqua ammonia again. When the liquid in the absorber is







fully charged with ammonia gas or to the degree desired, the liquid is pumped to the generator where a repetition of the process begins.

#### Compressed Air System:

In this system, air is the refrigerating medium but it is not condensed to the liquid state. The process consists in compressing air during which heat is generated. The heat is abstracted by means of cold water trickling over pipes containing the compressed and heated air. The air is then passed into an expander. Expansion of the air is accompanied by a reduction in pressure and corresponding fall in temperature. This cold air is then discharged into the refrigerating coils from where it is drawn again to the compressor and the cycle of operations repeated.

#### Vacuum Machine System:

The vapor vacuum system involves similar operations as in the compression system. Water is used as the refrigerating medium and the refrigerating or cooling effect is produced by the evaporation of a part of the liquid. The evaporation is obtained by producing and maintaining a vacuum that corresponds to the vapor tension of the liquid in the evaporator at the desired temperature. The vapor tension meaning that pressure at which the liquid would begin to vaporize at its surface. Since the heat required is not obtainable from an external source it will be removed from the liquid and this cooling permits the vapor when passed through the refrigerating coils to abstract heat from the compartment in which they are located, and the cycle is repeated.

#### Methods of applying refrigeration :

Refrigeration may be applied in either of two ways, direct or indirect.



Left chamber with volume  $V_1$  at the initial pressure  $p_1$  and temperature  $T_1$ .

Right chamber with volume  $V_2$  at the initial pressure  $p_2$  and temperature  $T_2$ .

### Compression of the gas

In this process, the gas is compressed from its initial volume  $V_1$  to a final volume  $V_2$ .

Compression is done by the piston. The pressure increases as the volume decreases.

During which heat is exchanged. The heat is exchanged with the surroundings.

Water falling over the piston causes the compression and heating of the gas.

The gas is then heated to a temperature  $T_2$  at a volume  $V_2$ .

By a piston in a cylinder and compressed to a volume  $V_2$  at a temperature  $T_2$ .

Cells are then distributed into the left chamber and the right chamber is in

thermal contact with the surroundings and the system is in thermal equilibrium.

### Expansion of the gas

The gas is then expanded from its initial volume  $V_1$  to a final volume  $V_2$ .

Expansion is done by the piston. The pressure decreases as the volume increases.

During which heat is exchanged. The heat is exchanged with the surroundings.

The gas is then heated to a temperature  $T_2$  at a volume  $V_2$ .

At the initial temperature. The gas is then heated to a temperature  $T_2$  at a volume  $V_2$ .

When the right chamber begins to expand at the initial temperature  $T_1$  and volume  $V_1$ .

Expansion is done by the piston. The pressure decreases as the volume increases.

During which heat is exchanged. The heat is exchanged with the surroundings.

The gas is then heated to a temperature  $T_2$  at a volume  $V_2$ .

At the initial temperature. The gas is then heated to a temperature  $T_2$  at a volume  $V_2$ .

### Heat of expansion

Heat of expansion is the heat exchanged during the expansion of the gas.

Heat of expansion



In the direct method the refrigerant or gas that produces the cooling is allowed to expand in the cooling coils and thus absorb heat directly from the surrounding chamber. This requires constant operation of the machinery for uninterrupted refrigeration unless duplicate machinery is provided.

In the indirect method, the refrigerating medium acts upon some auxiliary medium and this medium is carried in some systematic manner through the compartments to be cooled.

The indirect system may be applied one of two ways. The more common employs brine made either with sodium chloride (common salt) or chloride of calcium as the auxiliary refrigerating medium. Tanks for holding the brine and cooling it contain the refrigerating coils through which the gas is passed this cools the brine which being pumped through the coils in the refrigerating compartment lowers the temperature there. When this system is used, the compressor and brine tank capacities are usually large enough to permit operating the compressor only during a part of the 24 hours and then maintaining refrigeration the balance of the time by circularizing the brine. The less common employs air as the circulating medium. The air may be cooled either by the direct system or by the brine indirect system. In this system the cooling pipes are grouped in a room and the air is chilled in passing over them. It is maintained in circulation by blowers.

#### Artificial Ice Making:

Any of the methods of generating refrigeration described above and either the direct or indirect method of applying refrigeration may be employed in manufacturing artificial ice. Various details such as volumes to be handled and size of units required, and other technical considerations, make the compression system the one generally employed.



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The indirect brine circulating system is quite common.

#### Systems of Artificial Ice Making:

Three systems of manufacturing ice are in general use. They are known as the Can system, the Plate system and the Raw Water system. They differ mainly in the manner of freezing the water and the relative locations of the freezing mediums and the water.

#### Can System:

In the CanSystem the water to be frozen is surrounded by the freezing medium. Cans of galvanized iron containing the water to be frozen are immersed in a tank of iron or wood that contains the brine. The brine is kept at a low temperature in the indirect method of refrigeration and is agitated or kept in circulation by a propeller wheel. The freezing-point of the brine below the freezing-point of water, the amount depending upon the strength of the brine, permits its circulation in the liquid state while at a temperature below the freezing temperature of pure water. The ice forms inside on the walls of the can and as the process continues, becomes thicker until a solid block is produced. The cans are removable. They are dipped into tepid water or sprinkled to loosen the ice. They are made with tapering walls, being narrower at the bottom than at the top for easier removal of the cake. Refilling of the cans as soon as emptied permits a continuous process. Ice may be drawn throughout the 24 hours after the plant has been in operation long enough for one complete freezing.

The product obtained is known as distilled-water ice. The water obtained for filling the cans is obtained from the condensed exhaust steam from the main engines and auxiliaries having been purified by reboiling and filtering before filling the cans.

Since the growth of can ice is from all sides of the can, any



The first part of the report is devoted to a description of the work done during the last year. It is divided into two main sections: the first deals with the work done in the laboratory, and the second with the work done in the field. The first section is divided into three parts: the first part deals with the work done in the laboratory, the second with the work done in the field, and the third with the work done in the laboratory. The second section is divided into two parts: the first part deals with the work done in the field, and the second with the work done in the laboratory.

The second part of the report is devoted to a description of the work done during the last year. It is divided into two main sections: the first deals with the work done in the laboratory, and the second with the work done in the field. The first section is divided into three parts: the first part deals with the work done in the laboratory, the second with the work done in the field, and the third with the work done in the laboratory. The second section is divided into two parts: the first part deals with the work done in the field, and the second with the work done in the laboratory.

The third part of the report is devoted to a description of the work done during the last year. It is divided into two main sections: the first deals with the work done in the laboratory, and the second with the work done in the field. The first section is divided into three parts: the first part deals with the work done in the laboratory, the second with the work done in the field, and the third with the work done in the laboratory. The second section is divided into two parts: the first part deals with the work done in the field, and the second with the work done in the laboratory.

The fourth part of the report is devoted to a description of the work done during the last year. It is divided into two main sections: the first deals with the work done in the laboratory, and the second with the work done in the field. The first section is divided into three parts: the first part deals with the work done in the laboratory, the second with the work done in the field, and the third with the work done in the laboratory. The second section is divided into two parts: the first part deals with the work done in the field, and the second with the work done in the laboratory.



mechanically suspended impurities in the water will appear in the ice so formed at the center of the block and it is, therefore, essential that pure water free from such impurities be used. The size of block generally considered standard is 11" x 22" x 44" and weighs approximately 300 pounds.

#### Diagrammatic Layout of System:

Fig. 1 shows a diagrammatic layout of a can ice plant with the different lines indicated by characteristic symbols and arrows to show the direction of flow for each line. Fig. 2 shows the relative position of the different parts of the same layout shown in Fig. 1 with several units added that were omitted from Fig. 1 to avoid possible confusion. The lines are indicated in the same manner so that the different steps may be easily followed.

#### Plate System:

In the Plate system the water to be frozen is outside of the freezing medium. In this system a tank approximately 10 feet deep by 12 feet wide is used. This tank is divided into compartments 30 inches wide with the partitions made up of direct expansion piping to which are bolted 1/2 inch plates. These plates form the freezing surfaces. The ice-plate grows in thickness from one side only, from the freezing plate outward. Thus the mechanically suspended impurities are separated and thrown off by the slowly freezing water. They may be drained off from the bottom of the tank. Thawing of the ice-cake from the freezing plate is done by passing hot gas through the coils. Since this system does not require distilled water in order to manufacture clear ice, it may be electrically driven. The ice forms gradually in from eight to ten days to a thickness of 12 inches to 14 inches.



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The freezing tank area for the plate system is about twelve times that required for the can system and its contents about four times as much.

#### Can System vs. Plate System:

The Can system offers a practically continuous process of making ice, whereas in the Plate system the building up of the ice is slow and expensive so that for continuous operation several tanks are required so that one or more may be frozen while the others are being emptied. When a freezing is complete, the whole product is harvested, cut and stored in a few hours, the hoisting being by mechanical power. Hoisting in a can ice plant is usually by hand. The cost of the plate system is about one-third more than that of the can system.

#### Raw Water Ice Plants:

The manufacture of ice from raw or undistilled water is taking a prominent place in the ice industry. A clear merchantable ice may be manufactured from raw water if the water in the cans is agitated during the entire freezing period. This agitation is accomplished by discharging air at or near the bottom of the cans through a  $1/16$  inch opening and under a pressure of 3 to 6 pounds per square inch.

The impurities collect in the core. The water throws them off as it freezes and as the core is the last part to freeze they are deposited there. Before this is completely frozen, the unfrozen water contained within the block and heavily charged with impurities is pumped out and the space is refilled with raw water containing only the initial amount of impurities.

This system thus requires no distilling apparatus. Therefore, the most economical motive power available may be employed. Most raw water ice plants are electrically operated.







Information Required for Estimating the Cost of an Ice Making Plant:

In order to secure an estimate of the probable cost of an ice-making plant, the following information should be available to the firm estimating on the equipment:

1. The capacity of the plant, that is, the number of tons of ice required per 24 hours.
2. The quality of the ice desired, whether clear, crystal, transparent ice is demanded or whether opaque ice will answer.
3. The qualities of the water supply that will be frozen, the nature, quantity available and temperature.
4. If available source of steam supply is on the premises and if so what horse-power.
5. If existing buildings are to be used for the installation, a rough dimensioned plan should be made.
6. The price and quality of fuel.
7. The wages of engine men, stokers and common laborers for 12 hours' day work; for 12 hours night work.
8. The price of water, if it must be purchased.

Expense of Manufacture:

The operating expenses of an ice plant of a given capacity can usually be pre-determined since all the expenses connected with the factory are fixed quantities for given rates of production. It can well be considered a routine business. The greater the capacity of the plant, the less the cost per ton of production but plants having a daily capacity of one ton may prove remunerative investments. Other factors in addition to the influence of the capacity of the plant affect the cost of making ice and cause it to vary slightly in different localities. The cost of fuel



...



and labor are most liable to affect it. The difference, however, is generally such as to permit the manufacture in one part of the country at a final figure that does not differ greatly from that in another.

Purity:

Manufactured ice can be more wholesome, clearer and cleaner than natural ice and its use is often recommended by physicians for this reason. The water used is often distilled water which is, of course, free from all organic particles, disease germs, etc.

Natural vs. Artificial Ice:

The best natural ice is taken from the portable waters of our great Northern rivers and lakes or large and deep bodies of water which afford generally an immense harvest and under favorable conditions, clear crystal ice. This ice, however, if subjected to microscopic examination is filled with minute organic life, and, therefore, is not as pure as ice manufactured from distilled water.

Natural ice costs man nothing for its manufacture but the cost of cutting, harvesting, transporting and the loss by waste and meltage and the expense of storing is great enough to enable manufactured ice to enter into direct competition with it with the result that in cities as far north as New York, Philadelphia and Chicago ice dealers can operate ice factories at a satisfactory profit.

The great advantage of manufactured ice over natural ice in competition is the fact that it is made continually in the very market in which it is sold and consumed and, therefore, suffers almost no loss nor includes expenses of transportation and storage. The meltage loss of natural ice in transportation and storage is likely to be as high as 50 per cent while manufactured ice is supplied directly to the consumer almost directly from



The first part of the document is devoted to a general description of the project. It includes a brief history of the project, its objectives, and the scope of the work. The second part of the document is devoted to a detailed description of the project. It includes a description of the project's structure, its components, and its functions. The third part of the document is devoted to a description of the project's results. It includes a description of the project's achievements, its impact, and its future prospects.

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the freezing moulds with a minimum waste.

#### Establishing an Ice Factory:

The most important thing to be considered in the establishment of an ice factory is to the market for ice. Home and local dealer demands should be studied. These alone may not be sufficient to justify favorable consideration but possibly the proposed location may be such as to afford opportunity to serve as a center of supply for outlying towns reached easily by railroad, wagon or truck, so that when the whole field is considered, the aggregate demand may justify the erection of a plant of perhaps two tons or more capacity. It is usually safe to install a somewhat larger plant than demands might at first indicate as necessary for it is perhaps universally true that where plants have been erected, and the proper attention given the business, each year sees a growing demand that usually results in a constantly increasing and substantial business. A certainty of supply goes a long way toward creating a permanent demand.

#### Water Supply:

Next to a market for the ice, the most important consideration is the water supply for the factory. A reliable source should exist at all times and during all seasons. There should be an allowance of four gallons per minute for every ton of proposed ice-making capacity. The water should be suitable for feeding into the boilers. It is required for condensing the ammonia, filling ice moulds if a raw water plant is installed, distilling and cleaning. It should preferably be as cold and as pure as possible. Artesian or deep well water generally offers an excellent supply.

#### Ice-Factory Buildings:

Buildings for housing the equipment may be made of wood or brick. The building regulations or fire restrictions of the city or locality as







well as the means of the owner may determine. In many cases and especially for the smaller plants a plain and well-built wooden building is used. There should be a boiler room, and engine or ice-machine room, a tank room, ice-storage space with an anteroom and a business office. Condensing and distilling apparatus may be placed upon the roof or in a special room and should be protected by a roof with open sides of lattice or screened work so that a thorough air circulation exists. Outside the building a convenient platform for weighing and loading should be provided. If the locality offers an inducement for cold storage facilities, special cold storage rooms for butter, eggs and perishable products may also be included or added later.

#### Boiler Power:

It is preferable to provide two boilers, each capable of operating the entire plant so that continuous operation will not be interrupted when repairs and cleaning are required. The boilers should be of ample boiler power slightly in excess of the actual demands.

#### Operating the Plant:

The greatest production with the least possible cost is obtained by running the plant day and night and thus make the operation continuous. Every effort should be made to determine the operating conditions that insure the best quality and greatest quantity when determined should be held. Drawing the ice should be done with regularity. A definite number of cans should be pulled each hour day or night and it should be uniformly distributed over the whole area of the tank.

#### Cleanliness:

All parts of the apparatus should be kept clean and in good order.



The first part of the report deals with the general situation in the country. It is a very interesting and informative account of the state of affairs in the country at the time. The second part of the report deals with the specific details of the situation. It is a very detailed and thorough account of the situation in the country at the time. The third part of the report deals with the conclusions of the investigation. It is a very clear and concise summary of the findings of the investigation.

The fourth part of the report deals with the recommendations of the investigation. It is a very clear and concise summary of the recommendations of the investigation. The fifth part of the report deals with the conclusions of the investigation. It is a very clear and concise summary of the findings of the investigation.

The sixth part of the report deals with the conclusions of the investigation. It is a very clear and concise summary of the findings of the investigation. The seventh part of the report deals with the conclusions of the investigation. It is a very clear and concise summary of the findings of the investigation.

The eighth part of the report deals with the conclusions of the investigation. It is a very clear and concise summary of the findings of the investigation. The ninth part of the report deals with the conclusions of the investigation. It is a very clear and concise summary of the findings of the investigation.



The distilling apparatus, ice cans and tanks should be kept free from all dirty or foul matter. Provisions should be made for purging the entire distilling system with steam and the scrubbing brush and harmless solvents can be used to advantage upon many parts. The filter charge should be changed as often as possible.

Initial and Operating Costs of Ice Making Plants:

The figures given in the following table should be considered approximate only. They are taken from no particular installations, but are estimated costs believed to represent good average values affording a fairly just comparison between the costs of plants with different kinds of power. Ice plants may be operated by men engaged to do other work as well, in which case the labor costs given in the table could be reduced somewhat. A cold storage business or the operation of other machinery is often carried on in conjunction with the manufacture of ice. The figures given under daily operating expense are assumed to represent fair averages but they may require correction to suit local conditions. Such corrections may easily be made together with that for the price of fuel and by this means a figure attained to suit almost any case in question.

The figure for a building represents that required for a special building. If an existing building can be utilized, this item may be materially reduced. The labor item will not be the same throughout the year. When the plant is shut down or operated below full capacity, the labor item can be reduced one-half. The load factor or the number of months a year that full operation may occur has much bearing upon the cost of production. Columns 16 to 24, inclusive, are based on six (6) months full operation with plant shut down during the balance of the year. If the plant may be operated for a smaller part of the twelve (12) months, the figures would







necessarily be different. The cost of production would be higher.

#### RAW WATER ICE PLANTS

The quality of the water available largely determines the advisability of a raw water ice making installation. Most raw waters can be treated so that the ice is as good as that made from distilled water. This is especially true in cities.

Raw water ice plants are of two kinds, those using the plate system and those using the can system. The plate plant requires larger machinery, buildings, etc. and therefore the first cost is higher than for a can system. Consequently if for no other reason, the can system is the more popular.

There are two distinct types of the can system, (a) the removable can type and (b) the stationary can type. The former was originally patented about 20 years ago while the latter is of more recent origin.

Clear raw water ice made from water generally considered suitable for domestic use requires proper agitation of the water during the freezing process. If the agitation ceases, the water freezes as white ice.

The water is agitated by the introduction of air. Two methods of introducing air into the water are employed in the removable can type plant. The older method is by means of a small tube connected to an air pressure reservoir and fastened to the can, either on the inside or on the outside. The newer method is called the "drop pipe". It consists of a brass tube  $1/4$  to  $5/16$  inch in diameter dropped into the can at any convenient point, along the side, along the end or in the center. It seems to be immaterial where air is introduced. It is, however, essential that the air has been thoroughly dried, that is, that the moisture in it has been removed before it is forced into the volume of freezing water. Dry air will not freeze



THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

BY

JOHN BURNET

OF

THE UNIVERSITY OF OXFORD

IN TWO VOLUMES

THE FIRST

VOLUME

CONTAINING

THE HISTORY OF

THE REIGN OF

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THE UNIVERSITY OF OXFORD

IN TWO VOLUMES

THE SECOND

VOLUME

CONTAINING



but if it contains moisture, frozen tubes are likely to result.

With dry air introduced at pressures from 10 to 25 lbs. per sq. inch, it will continue to blow even after the ice has frozen and thus if dry air is used a perfectly clear block of ice will result except possibly a small deposit of impurities near the bottom of the air tube and a small streak of white ice which indicates the location of the air tube.

Agitation in the stationary can type is accomplished by introducing air at the bottom of the can. At the proper time the flow is stopped resulting in a certain amount of white core. The size of the core depends upon the quality of water used and the manner of freezing. If it contains considerable foreign substance, the size of the core will indicate it. If there is not much foreign substance present the core is likely to be smaller than is often found in distilled water ice provided the ice freezes perpendicularly and closes practically at one time through the length of the block. In case the freezing closes up at some point quicker than at another, a larger and more opaque core is apt to result due to a concentration of the foreign substances.

In distilled water plants, the ice must be "pulled" at rather regular intervals in order that the distilled water supply may be used to the best advantage. In raw water plants the pulling time need not be so regular since there is always on hand a constant supply of water. This fact tends toward a lower cost for harvesting raw water ice.

While raw water ice made from water considered suitable for domestic purposes may be sufficiently pure, it may be necessary to treat it before filling the cans so as to remove lime, magnesia or coloring matter and thus obtain a clearer block. Agitation will not remove disease germs.







Some foreign matter is thrown off from the water during the freezing process and tends to gather on the surface of the ice. The agitation of the water during freezing, carries these impurities to the center of the can and it is sometimes necessary to remove the core water before it freezes and refill the space with clear water.

Raw water plants as small as 6 tons capacity have been installed. It is necessary in distilled water plants to work a force for twelve hours continuously in order to have water for filling the cans. In raw water plants the can puller shift need be of only six or eight hours.

Either electric or steam drive may be used for a raw water plant. The cost of production should perhaps be considered above other things. The question is "how many dollars per year will it cost to turn out a given number of tons of ice". It is not well to rely on the number of tons of coal or kilo-watts of electricity that will be required to produce one ton of ice because there is danger of such figures representing the best conditions. During the year there are variations in demand and other conditions which affect the cost per ton. Therefore the safe way is to consider yearly output as against yearly cost.

Some steam plants no doubt produce ice more cheaply than some electric plants while the reverse is also true. Most steam plants use standard horizontal return tubular boilers and simple Corless engines. In order to produce power cheaply, the boiler plant should produce the greatest number of pounds of steam per pound of coal and the power plant or engine should produce the greatest horsepower for the least number of pounds of steam. Under these ideal conditions, steam power is very likely to be the more desirable.







In some respects an electric driven plant has much in its favor. The first cost is lower, it is cleaner and more economical of space, and if cheap current is available, the cost of operation may be lower but an economical steam plant in some instances will no doubt give a lower cost per ton.

A familiar question is "how much ice will a machine make per ton of coal". In a steam driven plant this is largely a question of boiler capacity and efficiency. A boiler plant that evaporates 10 pounds of water per pound of coal will produce more ice per ton of coal than one in which the evaporation is but 6 pounds per pound of coal. Every case requires careful consideration. There are no fixed rules by which the best power to use can be determined. Any comparison between steam and electricity as sources of power must be based on local conditions as they relate to the items given in the table.







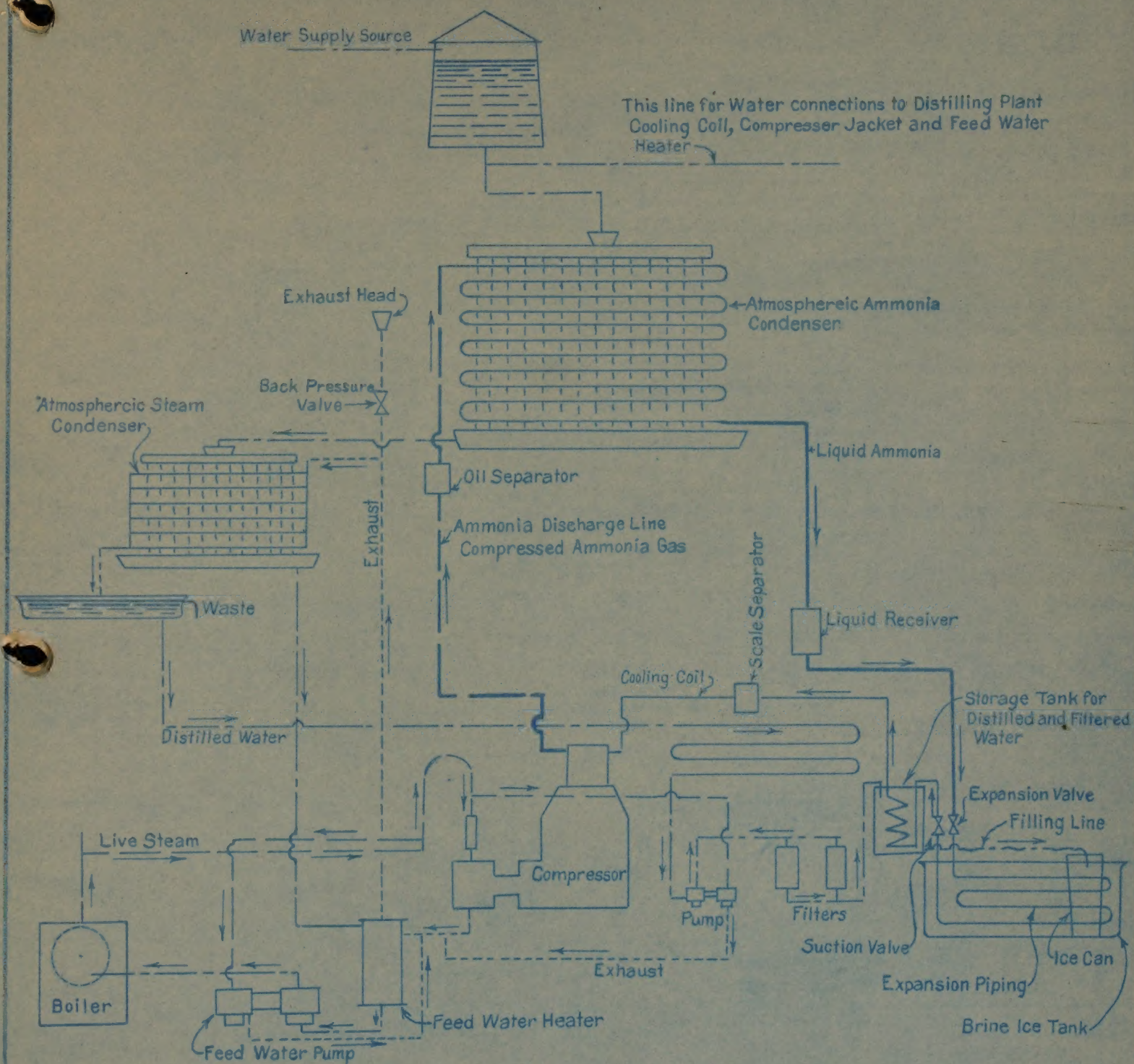


Fig. 2  
Diagrammatic Layout of a Can-Ice Plant

|                                                                   |            |                     |        |
|-------------------------------------------------------------------|------------|---------------------|--------|
| BUREAU OF PUBLIC ROADS<br>Division of<br>AGRICULTURAL ENGINEERING |            |                     |        |
| ICE MAKING                                                        |            |                     |        |
| Scale No Scale                                                    | CHECKED    | SHEET 1 OF 1 SHEETS |        |
| Drawn by                                                          | INCHES 1/2 | SUBJECT             | SERIAL |
| APPROVED                                                          |            | 642-C               | 1412   |







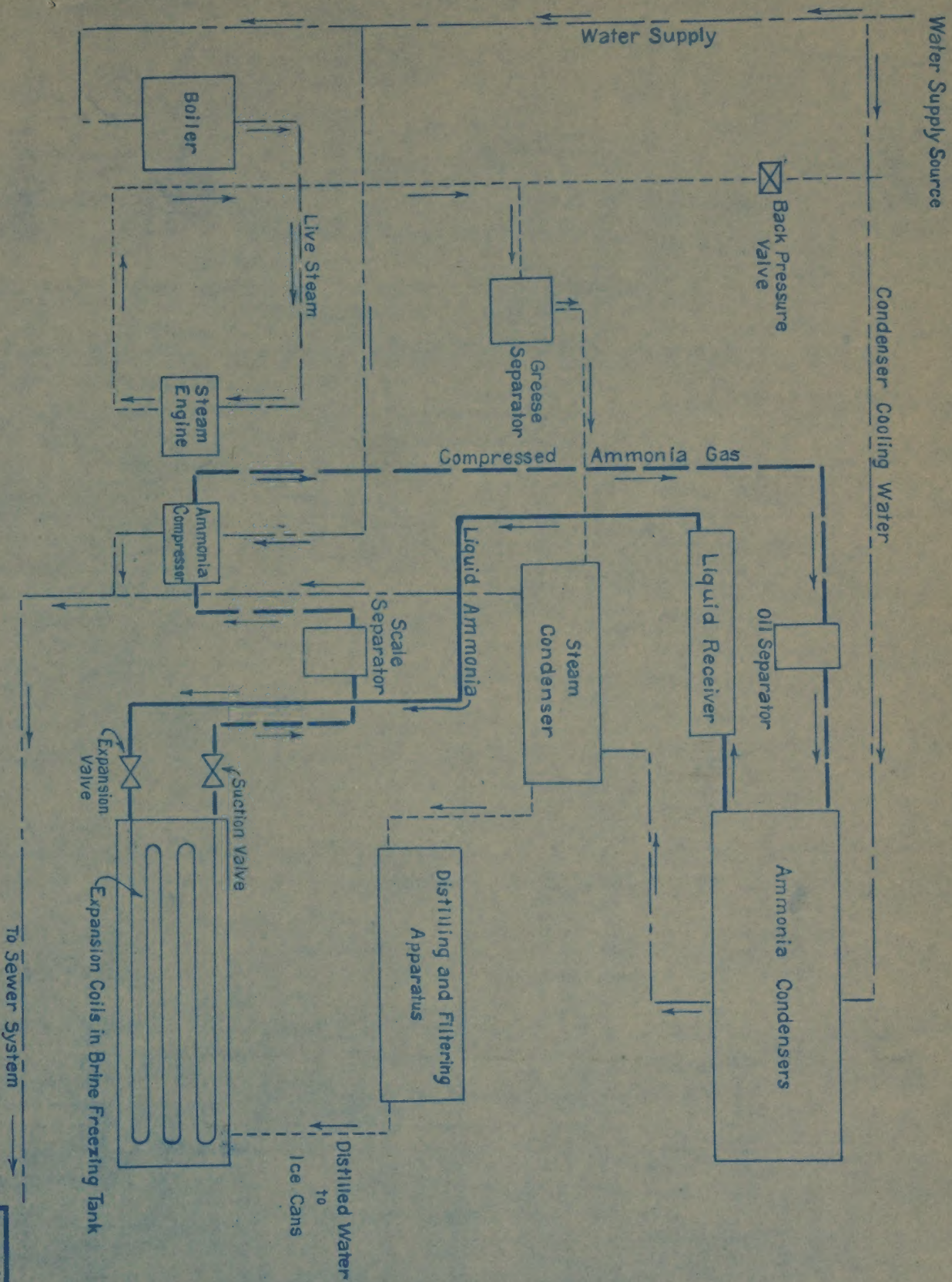


Fig. 1  
Diagrammatic Layout of a Can-Ice Plant

|                                  |                     |
|----------------------------------|---------------------|
| U.S. Department of Agriculture   |                     |
| Office of                        |                     |
| PUBLIC ROADS - RURAL ENGINEERING |                     |
| Division of                      |                     |
| RURAL ENGINEERING                |                     |
| ICE MAKING                       |                     |
| Scale: No 50212                  | CHECKED             |
| DESIGNED BY                      | SHEET 0 OF 0 SHEETS |
| DRAWN BY                         | SERIAL NO           |
| APPROVED                         | 51413               |





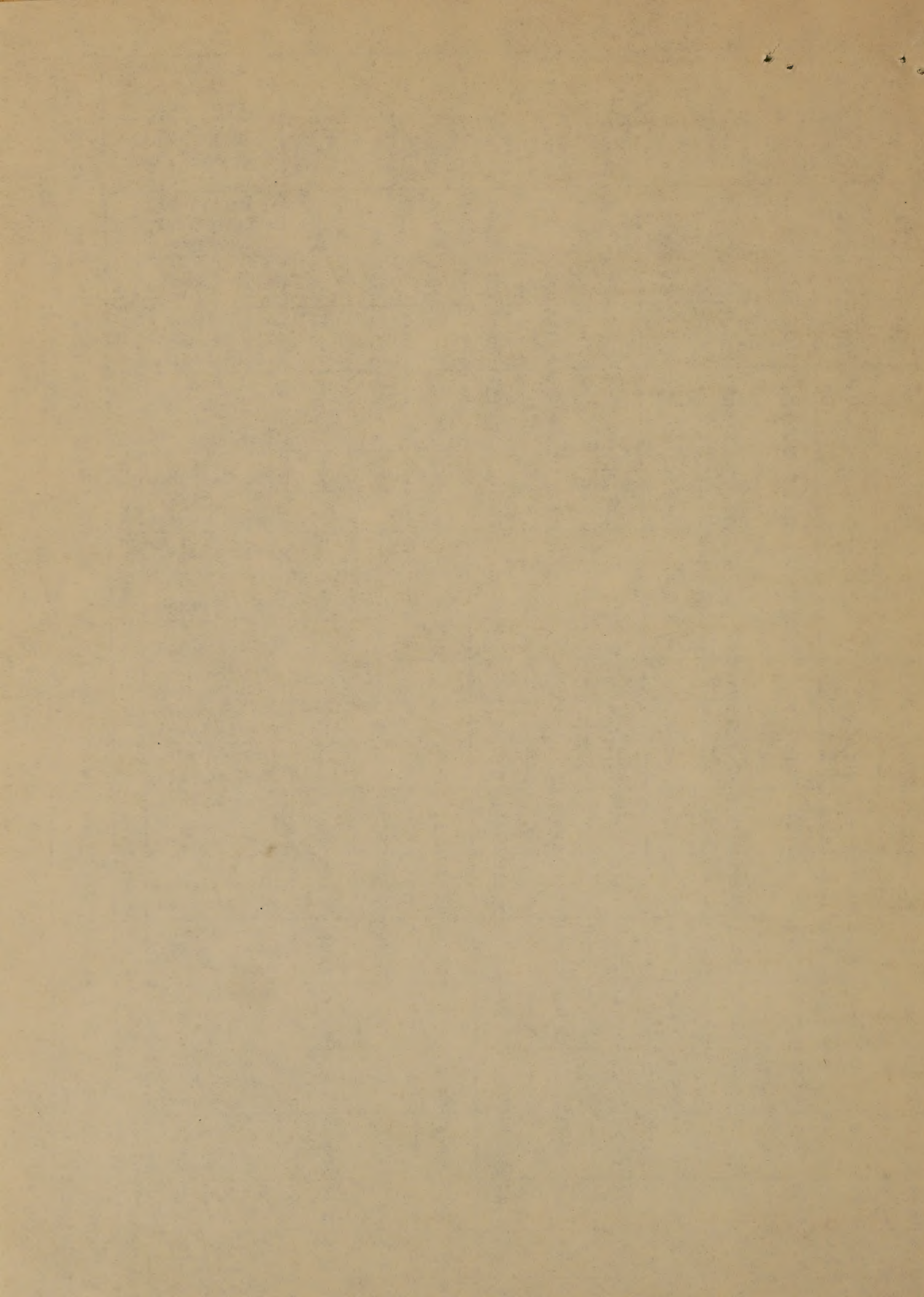


## ESTIMATED INITIAL AND OPERATING COSTS FOR ICE MAKING PLANTS OF 10-15-20-25 TONS PER 24 HOURS

| Capacity of Plant<br>Tons of Ice<br>per 24 Hours | Kind of Power<br>Type of Plant | INVESTMENT                          |          |                                       | DAILY OPERATING EXPENSES |                         |                     |                       |             |                          |                          |                                          |                                  |                                     | ECONOMICS ON BASIS OF SIX MONTHS FULL OPERATION |                                          |               |          |          |           |      |        |        |  |
|--------------------------------------------------|--------------------------------|-------------------------------------|----------|---------------------------------------|--------------------------|-------------------------|---------------------|-----------------------|-------------|--------------------------|--------------------------|------------------------------------------|----------------------------------|-------------------------------------|-------------------------------------------------|------------------------------------------|---------------|----------|----------|-----------|------|--------|--------|--|
|                                                  |                                | Mechanical<br>Equipment<br>Complete | Building | Total<br>Investment<br>Excluding Land | One<br>Day Engine Man    | One<br>Night Engine Man | One<br>Day Tank Man | One<br>Night Tank Man | Extra Labor | Coal<br>@ \$4.25 per Ton | Oil<br>@ 4 1/2¢ per Gal. | Electric Current<br>@ 2 1/2¢ per kw. hr. | Ammonia, Oil,<br>Waste, Supplies | Total Operating<br>Expenses per Day | Operating Expenses<br>During<br>Full Operation  | Half<br>Labor Expense<br>Balance of Year | FIXED CHARGES |          |          |           |      |        |        |  |
| 1                                                | 2                              | 3                                   | 4        | 5                                     | 6                        | 7                       | 8                   | 9                     | 10          | 11                       | 12                       | 13                                       | 14                               | 15                                  | 16                                              | 17                                       | 18            | 19       | 20       | 21        | 22   | 23     | 24     |  |
| 10                                               | Steam<br>Distilled<br>Water    | 10 625                              | 4 375    | 15 000                                | \$4.50                   | \$4.00                  | \$2.50              |                       |             | \$9.00                   |                          |                                          | \$2.00                           | \$22.00                             | \$4004.00                                       | \$1001.00                                | \$743.75      | \$131.25 | \$750.00 | \$6630.00 | 1820 | \$3.64 | \$4.47 |  |
|                                                  | Electric<br>Motor<br>Raw Water | 9 375                               | 3 750    | 13 125                                | 4.50                     | 4.00                    | 2.50                |                       |             |                          |                          | \$15.00                                  | 2.00                             | 28.00                               | 5096.00                                         | 1001.00                                  | 656.25        | 112.50   | 656.25   | 7522.00   | 1820 | 4.13   | 4.85   |  |
|                                                  | Oil<br>Engine<br>Raw Water     | 10 625                              | 3 750    | 14 375                                | 4.50                     | 4.00                    | 2.50                |                       |             |                          | \$3.18                   |                                          | 2.00                             | 16.18                               | 2944.76                                         | 1001.00                                  | 743.75        | 112.50   | 718.75   | 5520.76   | 1820 | 3.04   | 3.84   |  |
|                                                  | Steam<br>Distilled<br>Water    | 14 375                              | 5 625    | 20 000                                | 4.50                     | 4.00                    | 2.50                | \$2.50                |             | 12.25                    |                          |                                          | 3.00                             | 28.75                               | 5232.50                                         | 1228.50                                  | 1006.25       | 168.75   | 1000.00  | 8636.00   | 2730 | 3.16   | 3.90   |  |
| 15                                               | Electric<br>Motor<br>Raw Water | 12 500                              | 5 000    | 17 500                                | 4.50                     | 4.00                    | 2.50                | 2.50                  |             |                          |                          | 22.25                                    | 3.00                             | 37.75                               | 6810.50                                         | 1228.50                                  | 875.00        | 150.00   | 875.00   | 9999.00   | 2730 | 3.66   | 4.31   |  |
|                                                  | Oil<br>Engine<br>Raw Water     | 14 375                              | 5 000    | 19 375                                | 4.50                     | 4.00                    | 2.50                | 2.50                  |             |                          | 4.78                     |                                          | 3.00                             | 21.28                               | 3872.96                                         | 1228.50                                  | 1006.25       | 150.00   | 968.75   | 7226.46   | 2730 | 2.65   | 3.36   |  |
|                                                  | Steam<br>Distilled<br>Water    | 15 625                              | 6 875    | 22 500                                | 5.25                     | 4.00                    | 2.50                | 2.50                  |             | 15.80                    |                          |                                          | 4.00                             | 34.05                               | 6197.10                                         | 1297.66                                  | 1093.75       | 206.25   | 1125.00  | 9919.76   | 3640 | 2.73   | 3.34   |  |
|                                                  | Electric<br>Motor<br>Raw Water | 13 750                              | 6 250    | 20 000                                | 5.25                     | 4.00                    | 2.50                | 2.50                  |             |                          |                          | 28.80                                    | 4.00                             | 47.05                               | 8563.10                                         | 1297.66                                  | 962.50        | 187.50   | 1000.00  | 12010.76  | 3640 | 3.30   | 3.85   |  |
| 20                                               | Oil<br>Engine<br>Raw Water     | 15 625                              | 6 250    | 15 875                                | 5.25                     | 4.00                    | 2.50                | 2.50                  |             |                          | 6.38                     |                                          | 4.00                             | 24.63                               | 4482.66                                         | 1297.66                                  | 1093.75       | 187.50   | 793.75   | 7853.32   | 3640 | 2.16   | 2.60   |  |
|                                                  | Steam<br>Distilled<br>Water    | 18 750                              | 8 125    | 26 875                                | 5.25                     | 4.50                    | 2.50                | 2.50                  |             | 18.90                    |                          |                                          | 5.00                             | 41.15                               | 7489.30                                         | 1570.66                                  | 1312.50       | 243.75   | 1343.75  | 11959.96  | 4550 | 2.63   | 3.22   |  |
|                                                  | Electric<br>Motor<br>Raw Water | 16 625                              | 7 500    | 24 125                                | 5.25                     | 4.50                    | 2.50                | 2.50                  |             |                          |                          | 37.50                                    | 5.00                             | 57.25                               | 10419.50                                        | 1343.16                                  | 1163.75       | 225.00   | 1206.25  | 14357.66  | 4550 | 3.16   | 3.69   |  |
|                                                  | Oil<br>Engine<br>Raw Water     | 18 750                              | 7 500    | 26 250                                | 5.25                     | 4.50                    | 2.50                | 2.50                  |             |                          | 7.98                     |                                          | 5.00                             | 27.73                               | 5046.86                                         | 1343.16                                  | 1312.50       | 225.00   | 1312.50  | 9240.02   | 4    | 2.03   | 2.61   |  |
| 25                                               | Steam<br>Distilled<br>Water    | 18 750                              | 8 125    | 26 875                                | 5.25                     | 4.50                    | 2.50                | 2.50                  |             | 18.90                    |                          |                                          | 5.00                             | 41.15                               | 7489.30                                         | 1570.66                                  | 1312.50       | 243.75   | 1343.75  | 11959.96  | 4550 | 2.63   | 3.22   |  |
|                                                  | Electric<br>Motor<br>Raw Water | 16 625                              | 7 500    | 24 125                                | 5.25                     | 4.50                    | 2.50                | 2.50                  |             |                          |                          | 37.50                                    | 5.00                             | 57.25                               | 10419.50                                        | 1343.16                                  | 1163.75       | 225.00   | 1206.25  | 14357.66  | 4550 | 3.16   | 3.69   |  |
|                                                  | Oil<br>Engine<br>Raw Water     | 18 750                              | 7 500    | 26 250                                | 5.25                     | 4.50                    | 2.50                | 2.50                  |             |                          | 7.98                     |                                          | 5.00                             | 27.73                               | 5046.86                                         | 1343.16                                  | 1312.50       | 225.00   | 1312.50  | 9240.02   | 4    | 2.03   | 2.61   |  |
|                                                  | Steam<br>Distilled<br>Water    | 18 750                              | 8 125    | 26 875                                | 5.25                     | 4.50                    | 2.50                | 2.50                  |             | 18.90                    |                          |                                          | 5.00                             | 41.15                               | 7489.30                                         | 1570.66                                  | 1312.50       | 243.75   | 1343.75  | 11959.96  | 4550 | 2.63   | 3.22   |  |

accompany Information Series No 42







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

*Superseded*  
*7. B 1480*

Information Series No. 43.

November, 1921.

CONCRETE SIDEWALKS, FEEDING FLOORS, CURBS AND STEPS.

Most walks are laid out in a straight line but frequently the contour of the ground, obstacles or the desire to secure artistic effects may require the use of curves. If used for artistic reasons a good plan is to plant shrubbery or trees in the section of the ground enclosed by the inside curve, thus creating an excuse for the departure from a straight line and at the same time discouraging persons making a "short cut" across the lawn. To prevent slipperiness and to assure a comfortable foothold on a smooth surface the grade should not be too steep.

When a steep slope is necessary the surface of the concrete should be roughened. A steep grade occasionally can be avoided by following around a hillside or using steps. Steps are a nuisance and often dangerous and if unavoidable should be located in expected places and not immediately behind a hidden curve or where they will be overshadowed by adjacent objects. Five or six steps grouped in one flight make for more comfortable and safer walking than one or two placed at intervals.

In locations where snow is liable to drift or lie for a considerable length of time it is advisable to place the walk a little higher than the surrounding ground as the wind is more likely to keep the surface clear of snow and water will readily run off. The drainage of a walk is also assured by making one of its sides a trifle lower than the other, say, from  $1/8$  to  $1/4$  inch for each foot of width; or the walk may be crowned, that is, the center made higher than the sides.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
DIVISION OF ENTOMOLOGICAL ENGINEERING

November, 1931.

Information Service No. 47

CONCRETE CURBS, RIVERS, STAGES, DAMS AND WEIRS

Most water and land are in a straight line but frequently the  
bottom of the ground, sometimes on the bottom to secure suitable surface  
and regulate the use of water. It is for this reason that a good plan  
is to place straight or cross in the section of the ground outlined  
by the inside curve, thus creating an opening for the drainage from a straight  
line and at the same time discharging water into a "short cut" across  
the line. To prevent alligation and to secure a satisfactory result  
on a smooth surface the grade should not be too steep.

When a steep slope is necessary the surface of the concrete should  
be roughened. A steep grade occasionally can be avoided by following around  
a hillside or using steps. Steps are a nuisance and often dangerous and if  
conveniently should be located in exposed places and not immediately behind  
a higher curb or where they will be overlooked by adjacent objects. The  
on one side grouped in one flight with for low, comfortable and water  
walking them can be too placed at intervals.

In locations where snow is liable to drift or ice for a considerable  
length of time it is advisable to place the curb a little higher than the  
surrounding ground so the wind is more likely to keep the surface clear  
of snow and water will readily run off. The drainage of a curb is also  
secured by making one of the sides a little lower than the other, say  
from 1/8 to 1 1/4 inch for each foot of width; or the curb may be crowned  
that is, the center more higher than the sides.



Concrete walks should be located where the drainage is good but if this is impracticable a porous sub-base or cushion of cinders, sand or fine gravel must be provided to prevent the heaving caused by frost action and unequal settlement when the ground is wet. In stiff, clayey soils drainage should be provided to carry off any water which might otherwise remain in the foundation and cause injury by freezing.

In preparation for the sub-base the ground should be excavated to the proper depth for the full width of the walk, all soft or spongy spots being rammed firm and any consequent depressions filled to the established level. The depth of the excavation is dependent upon the climate and the nature of the soil. Where the ground is soft or subject to the action of frost the excavation should be from 10 to 12 inches deep; where no frost action occurs and the soil is sandy and not likely to become soft or water-soaked a sub-base is unnecessary and the excavation is made only to the depth of the slab but the soil should be thoroughly tamped and wetted.

The sub-base should be thoroughly rammed to present a firm, unyielding surface and if sand or cinders are used they should be thoroughly wet when being compacted.

Only good Portland cement of a reliable brand should be used. The sand and stone should be free of foreign materials and weak particles and should be well graded in regard to size. The coarser aggregate for the base should vary in size from  $1/4$  to  $1-1/2$  inches but should not be larger than 1 inch for one course walks. The sand, especially for the top coat, should be coarse and free from particles of earth, clay or other material that might swell or wash out after the surface has hardened, thus leaving pit holes. A sand 60 per cent of which is composed of  $1/8$  to  $1/4$  inch grains is not too coarse; all dust being eliminated.







Concrete walks are of the one-course or two-course type. In the two-course type the concrete is placed in two layers; a thick base of concrete and a thin top coat of rich mortar; in the one-course type, the concrete, of a fairly rich mixture, is placed in one layer.

The two-course type is the most used. The base for a 4 or 5 inch slab generally is  $3 \frac{1}{4}$  or  $4 \frac{1}{2}$  inches thick respectively and the concrete is usually mixed in the proportions of 1:2-1/2:5 though 1:3:6 will give good results when first class materials are used.

The top coat should never be less than  $\frac{3}{4}$  inch thick and is sometimes made 1-1/2 inches thick as when subjected to heavy loads. This coating usually is composed of mortar mixed in the proportions of 1:2 although a 1:1-1/2:3 mixture is often employed, stone from  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in size being used as the coarser aggregate.

#### One Course Walk

The concrete usually is mixed in the proportions of 1:2:3 or 1:2:4. The coarser aggregate is forced down by tamping until the mortar flushes to the surface. This will produce as good a walk as the two-coat method but is probably best used where a rough surface is desired as for roadways or feeding floors.

Forms should be provided along the sides of the walk to confine the concrete and, when the walk is cast in blocks, transverse forms are used. Usually 2 inch lumber of a width equal to the thickness of the concrete slab is used as forms for the straight run of the walk, although 1 inch lumber will sometimes serve if it is well staked and braced to prevent bulging. Satisfactory forms for curves may be made of  $\frac{1}{2}$  or 1 inch boards. Sheet metal forms can be had and may prove economical if considerable amount of walk is to be laid.







The forms are generally placed after the cushion has been laid and are held to line and grade by stakes driven on the outside. See Fig. 1. Marks should be made on the side forms where expansion joints or divisions are to be located so that the grooves in the top coat can be placed exactly over the joints in the base.

It is necessary to lay the concrete base in blocks with definite lines of separation so that cracks due to settlement or temperature changes will be made to occur in straight, well defined rather than irregular lines. For appearance sake the blocks should be nearly square. A slab 4 inches thick is sufficient for walks between 4 and 6 feet wide and 5 inches for an 8 foot width. The thickness of the slab should be increased to 6 inches at road crossings and if the traffic is heavy or the foundation insecure, a greater thickness may be required.

The separation into blocks may be accomplished in different ways. The base concrete may be laid in a convenient length and blocks formed by cutting entirely through the base with a trowel at the joint lines, after which the top coat is laid and grooves made immediately over the base joints. Blocks may also be formed by placing a thin beveled strip of wood or other material at the joint extending across the width of the walk and projecting through the top coat. The strips are removed after the concrete has hardened. The most satisfactory method of forming blocks is to cast them alternately in which case tar paper or sand is commonly used to separate adjacent blocks of the base course.

#### Expansion Joints.

When the base is not laid in separate blocks expansion joints will be necessary. They should be located at buildings, trees, curbs, both







ends of curves, around manholes and every 40 feet of straight run of walk. These joints are made by leaving spaces from  $1/4$  to  $1/2$  inch wide and filling them with sand or tar.

In mixing, the materials should be measured by volume and for the top coat should be very exactly measured to assure a uniform color. Concrete for the base and for one-course walks should be mixed to the consistency of jelly but that for a top coat should be about the consistency of mortar for laying brick.

#### Placing the Concrete.

Just before depositing the base-concrete the cushion should be thoroughly wetted down with water. After the concrete is placed it is lightly rammed and leveled off with a straight-edged board, notched over the side forms to leave a proper depth for the top coat. The mortar top coat is placed as soon as a few of the base blocks have been laid and is struck off even with the side forms after which the surface is roughly floated with a plasterers' trowel. The final floating is not done until the mortar has been in place from 2 to 5 hours, when it has partially set. For this operation a wooden float is first used and then a metal float or plasterers' trowel. It is sometimes the custom to sprinkle over the surface a thin layer of "dryer", a dry mixture of 1 part cement and 1 part sand, which is then troweled smooth. This is not desirable as it tends to make the walk glassy.

The top coat should be cut through directly over the joints in the base which are located by placing a straight-edge at the marks previously made on the side forms and found exactly by running the point of a small trowel through the top coat and into the base joint. The trowel is guided by the straight-edge and run across the width of the walk until a complete







cut is made. The four edges of each block are then rounded off by a grover or edging tool which leaves a small, hand-like mark about 1-inch wide. A float is then used to erase any marks or rough places and to give the surface its final finish. To produce a rough surface a dotted roller may be employed or a little sharp sand sprinkled over the surface and lightly rubbed with a wood float operated with a circular motion.

Too much troweling of the surface or troweling too soon causes a slippery surface and brings an excess of mortar to the top thus reducing the wearing qualities of the walk and causing "dusting"; troweling, especially with a steel float, after the concrete has set fairly hard produces craze or fine cracks. The exact time to trowel is best learned by experience.

Newly placed concrete should be protected with a moist covering of earth or other material as soon as practicable without marring the surface. The covering should be kept moist for a week and traffic kept off the walk for at least a week or ten days after placing the concrete.

It is not advisable to lay concrete walks in freezing weather but if unavoidable the walk should be very carefully protected. Manure should never be used to cover newly laid concrete as it contains acids which act on the green concrete.

#### TO FIND QUANTITIES OF MATERIALS IN A WALK

##### Example.

How much cement, sand, and gravel are required for a walk 3 feet wide and 100 feet long, having a 4 inch base, mixed in the proportion 1:2-1/2:5 and a 1/2 inch top coat, mixed in the proportions 1:2.

There are  $3 \times 100 = 300$  square feet in the walk.

In Table II opposite 4, in the third column will be found that 7.09 bag cement, 0.57 cu.yds. sand, 1.14 cu.yds. gravel are required for 100 sq.ft. Multiplying by 3, then 21.27 bags cement, 1.71 cu.yds. sand, 3.42 cu.yds. gravel are required for the base.

In Table I opposite 1/2 in the third column will be found that 2.12 bag cement, and 0.15 cu.yds. sand are required for 100 sq. ft. Multiplying by 3, then 6.36 bags cement, 0.45 cu.yds. sand are required for the top.

Therefore 14 bags cement, 1 cu. yd. sand, and 1.14 cu.yds. gravel are necessary.







QUANTITIES OF MATERIALS FOR CONCRETE SLABS  
( for an area of 100 square feet)

TABLE I

| Surface<br>thick-<br>ness in<br>inches | PROPORTIONS |      |         |      |      |      |           |      |      |
|----------------------------------------|-------------|------|---------|------|------|------|-----------|------|------|
|                                        | 1:1         |      | 1:1-1/2 |      | 1:2  |      | 1:1-1/2:3 |      |      |
|                                        | C           | S    | C       | S    | C    | S    | C         | S    | G    |
|                                        | bags        | c.y. | bags    | c.y. | bags | c.y. | bags      | c.y. | c.y. |
| 1/4                                    | 1.6         | .06  | 1.23    | .07  | 1.06 | .08  | .59       | .03  | .065 |
| 1/2                                    | 3.20        | .12  | 2.56    | .14  | 2.12 | .15  | 1.18      | .06  | .13  |
| 3/4                                    | 4.92        | .19  | 3.92    | .22  | 3.24 | .24  | 1.77      | .10  | .20  |
| 1                                      | 6.64        | .24  | 5.28    | .30  | 4.36 | .32  | 2.36      | .13  | .26  |

TABLE II

| Base<br>thick-<br>ness in<br>inches | PROPORTIONS |      |      |       |      |      |           |      |      |       |      |      |
|-------------------------------------|-------------|------|------|-------|------|------|-----------|------|------|-------|------|------|
|                                     | 1:2:3       |      |      | 1:2:4 |      |      | 1:2-1/2:5 |      |      | 1:3:6 |      |      |
|                                     | C           | S    | G    | C     | S    | G    | C         | S    | G    | C     | S    | G    |
|                                     | bags        | c.y. | c.y. | bags  | c.y. | c.y. | bags      | c.y. | c.y. | bags  | c.y. | c.y. |
| 1/2                                 | 1.05        | .08  | .12  | 0.9   | .07  | .13  | .88       | .07  | .14  | .65   | .072 | .14  |
| 1                                   | 2.1         | .16  | .24  | 1.9   | .14  | .28  | 1.77      | .14  | .29  | 1.31  | .144 | .29  |
| 3                                   | 6.4         | .48  | .71  | 5.8   | .41  | .83  | 5.32      | .43  | .85  | 3.93  | .432 | .87  |
| 4                                   | 8.6         | .64  | .95  | 7.7   | .55  | 1.11 | 7.09      | .57  | 1.14 | 5.24  | .576 | 1.16 |
| 5                                   | 10.7        | .81  | 1.18 | 9.6   | .69  | 1.38 | 9.86      | .72  | 1.42 | 6.56  | .722 | 1.44 |
| 6                                   | 12.9        | .97  | 1.42 | 11.2  | .83  | 1.64 | 10.64     | .85  | 1.71 | 7.87  | .866 | 1.73 |

### CONSTRUCTION OF CURBS

Both two-course and one course construction are used but the tendency now is toward one-course work - the same mixture throughout. A good finish can be obtained by properly tamping and spading the concrete, removing the forms as soon as practicable and troweling the surface.

The single curb is usually built 6 to 8 inches thick at the top, 9 to 12 inches thick at the bottom and 18 to 24 inches deep. Fig. 2 shows how the forms are constructed and braced. Fig. 3, shows the size



QUANTITIES OF MATERIALS FOR CONCRETE GRADE  
(For an area of 100 square feet)

| TABLE I | Concrete Grade | 1:1  | 1 1/2:1 | 2:1  | 3:1  | 4:1  | 5:1  | 6:1  | 7:1  | 8:1  | 9:1  | 10:1 |
|---------|----------------|------|---------|------|------|------|------|------|------|------|------|------|
| 1       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10      | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| TABLE II | Concrete Grade | 1:1  | 1 1/2:1 | 2:1  | 3:1  | 4:1  | 5:1  | 6:1  | 7:1  | 8:1  | 9:1  | 10:1 |
|----------|----------------|------|---------|------|------|------|------|------|------|------|------|------|
| 1        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9        | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10       | 0.00           | 0.00 | 0.00    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

CONSTRUCTION OF CURBS

Both two-course and one-course construction are used but the two-course is more common. The two-course work is the standard throughout. A good finish can be obtained by properly tamping and grading the concrete. The form is used as a guide in setting the surface. The single curb is usually built 6 to 8 inches thick at the top. 3 to 12 inches thick at the bottom and 12 to 24 inches long. The 3 to 12 inches thick at the bottom is the standard size. The 3 to 12 inches thick at the bottom is the standard size.



of curb and construction of forms for combined curb and gutter.

If the soil requires a sub-base, gravel or cinders to a thickness of 6 inches may be used. The concrete may be 1:2:4 or 1:2-1/2:5. If no sub-base is provided expansion joints should be made approximately every 25 feet. The curb should be built in sections as in sidewalk construction and the sections should be not over 10 feet in length.

Curbs may be constructed as pre-cast sections which should be reinforced. All corners and angles should be rounded and where wheels are likely to rub, metal nosing is advisable.

#### FEEDING FLOORS.

In choosing the site for a feeding floor consideration should be given to the natural drainage of the ground, convenience with regard to feed supply, proximity to stock shelter, means of watering stock upon the floor and protection from winter winds.

The construction of a feeding floor or barnyard pavement does not differ from the construction of walks; in fact, such floors may be considered as several walks placed side by side. See Fig. 4. Conditions requiring cushions or sub-bases are met in the same manner as for walks.

The shape is immaterial though most floors are square; while the size is dependent upon the number and kind of stock to be fed.

Either the one or two course type of floor can be used though the one course type is the more common. The floor should be at least 5 inches thick but a 4 inch slab probably is sufficient when hogs only are fed. The floor should have a slight slope toward a gutter at one side. The latter should slope so as to carry off liquids, preferably to a manure pit, or through the drains, to a sump. A curb is desirable at the sides of the



of work and construction of house for various work and garden.  
If the soil requires a sub-base, gravel or similar in a thickness  
of 6 inches may be used. The concrete may be laid on 1 1/2" - 2" of  
sand base is provided expansion joints should be made at intervals every  
25 feet. The work should be built in sections as far as possible  
and the sections should be not over 10 feet in length.  
There may be constructed as pre-cast sections which should be  
reinforced. All corners and angles should be rounded and where  
and likely to be used, where needed is advisable.

FOUNDING PIER.

In choosing the site for a building floor construction should be  
given to the natural drainage of the ground. Compensation with regard to  
the water, generally to stone masonry, masonry of masonry, stone and the  
floor and construction from water with.  
The construction of a building floor or basement foundation must not  
differ from the construction of a wall in fact, such floors must be constructed  
on external walls, placed side by side. See Fig. 4. Construction requiring  
sections or sub-base are not in the same manner as for walls.  
The shape is immaterial though most floors are square, while the  
also is important upon the nature and kind of work to be laid.  
Either the one or two courses type of floor can be used though the  
one course type is the more common. The floor should be at least 6 inches  
thick but a inch and a half is sufficient when laid on one foot. The  
floor should have a slight slope towards a gutter at one side. The lower  
should slope so as to carry all liquid, preferably to a gutter, but  
the drainage, to a drain, is a matter to be decided at the time of the



feeding floor, when not adjacent to a building or wall, to retain feed and the floor should also be protected by an apron wall extending a foot or more below the ground surface to prevent undermining.

The size of the slabs should be limited to 6 feet square.

It is not necessary to provide forms for the whole area. Forms for one row of slabs only need be provided and when this strip is concreted the forms may be removed and placed for the next strip.

#### STEPS.

The vertical height or face of a step is called the "riser" and the horizontal surface the "tread". Concrete steps are built by casting the risers and treads on a slab the thickness of which depends upon the span and the method of support. If the slab is not to be laid on solid ground reinforcement is necessary.

The concrete is mixed in the proportions of 1:2:3 or 1:2:4 but where a  $\frac{3}{4}$  inch top coating of mortar is applied the mixture may be 1:3:6. The concrete should be mixed fairly dry so that when placed, it will not be forced over the riser forms at the bottom of the stairs by the pressure of the concrete above. Where there are only three or four steps from 3 to 4 feet wide and supported by the ground, the concrete slab need be only 4 inches thick but for wider and longer flights the slab should be 6 inches or more. The surface of the tread should be finished as soon as the base concrete is placed. A rough or sand surface offers a better foothold. The treads should have a pitch of  $\frac{1}{32}$  to  $\frac{1}{16}$  inch toward the front in order to shed water. While it is not necessary, yet it is a good plan to project the tread  $\frac{1}{2}$  to  $\frac{3}{4}$  inch beyond the riser.







Two methods of building forms for plain concrete steps are shown in Fig. 5 (a) is used when jambs or curbs are desired and (b) for steps without curbs.

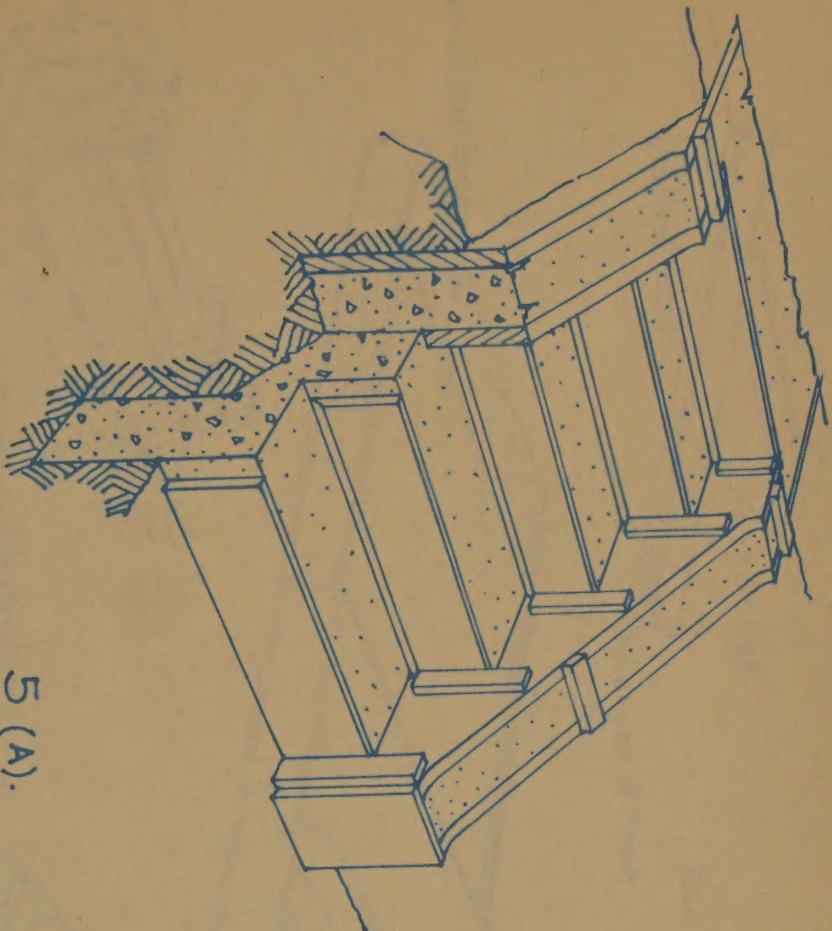
For comfort, the riser should bear a certain relation to the width of the tread and at the same time, should be between 6 and 8 inches in height. A rule giving a comfortable proportion is -- twice the height of the riser plus the width of the tread should equal 24. Low risers and broad treads generally are preferable for outside steps.

Drawings 1516 and 1517 accompany.

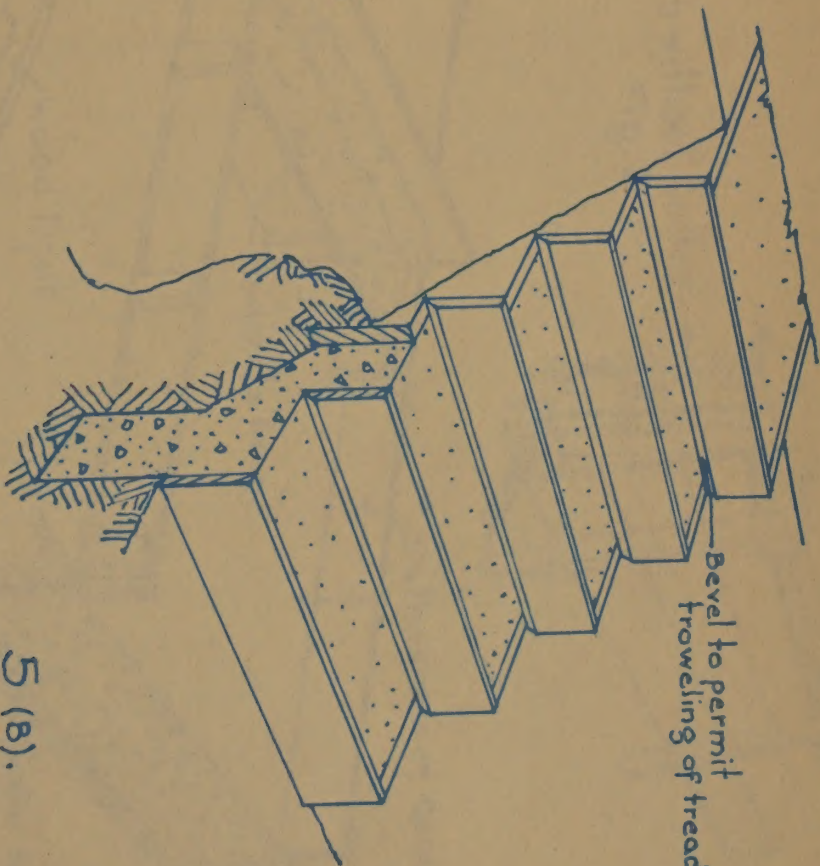




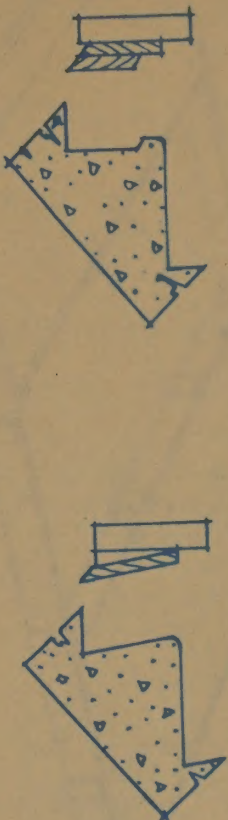




5 (A).



5 (B).



Methods of forming Risers.

# CONCRETE FORMS

U.S. DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF  
AGRICULTURAL ENGINEERING

Scale  
Drawn by K.E.  
Traced by M.B.  
Approved

CHECKED

SHEET 1 OF 1 SHEETS

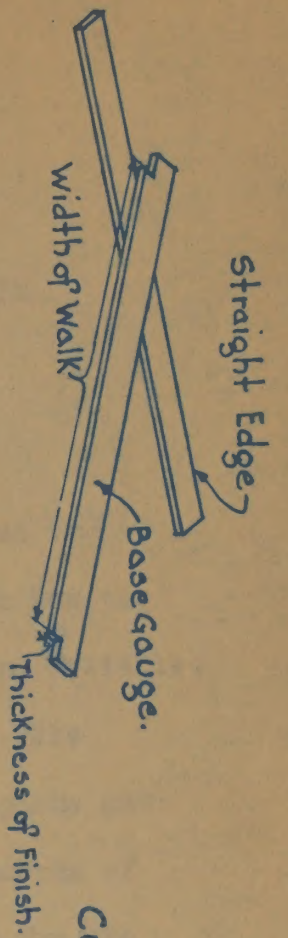
SUBJECT NO. SERIAL NO.

605-1-516

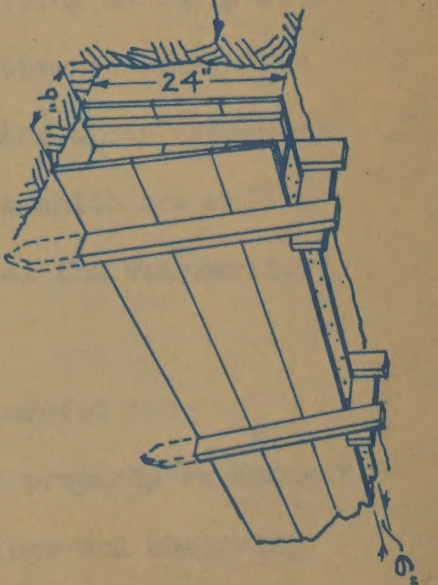




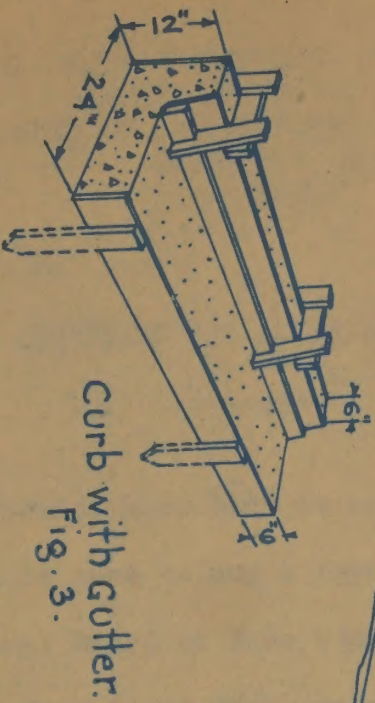




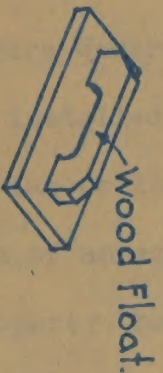
Curb without Gutter  
Fig. 2.



Finished surface



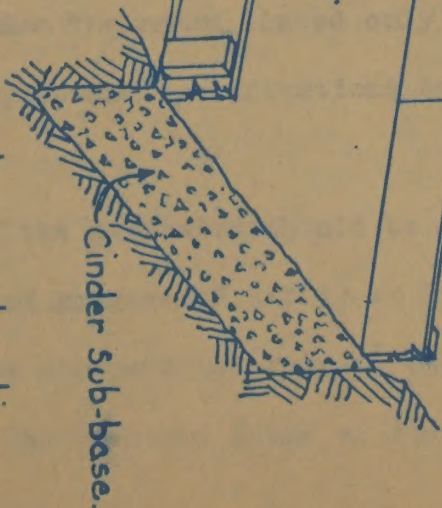
Curb with Gutter.  
Fig. 3.



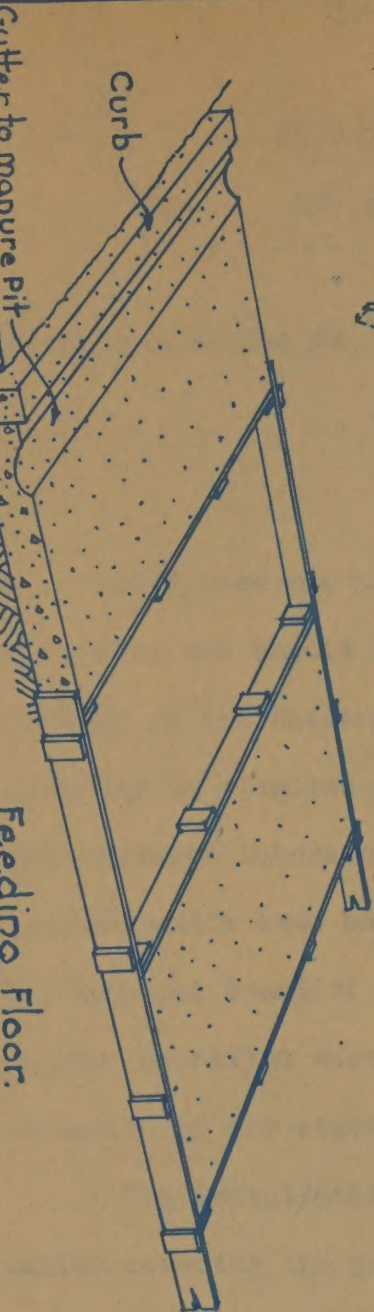
Wood Float.

Concrete Base.

2" Thickness of Concrete.



Details of Sidewalk construction.  
Fig. 1.



Feeding Floor.  
Fig. 4.

1517

|                                       |                     |
|---------------------------------------|---------------------|
| U.S. DEPARTMENT OF AGRICULTURE        |                     |
| BUREAU OF PUBLIC ROADS                |                     |
| DIVISION OF AGRICULTURAL ENGINEERING. |                     |
| CONCRETE FORMS                        |                     |
| Scale                                 | CHECKED             |
| Drawn by M.B.                         | SHEET 1 OF 1 SHEETS |
| Traced by M.B.                        | SERIAL N°           |
| APPROVED                              | 60 1517             |







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING  
WASHINGTON, D.C.  
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Information Series No. 44.

December, 1921.

ACETYLENE GAS LIGHTING PLANTS.  
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Acetylene gas plants have been in use for many years but in purchasing one should be sure to buy a type of generator which has the approval of the National Board of Fire Underwriters as safe and reliable. There may be obtained from local fire insurance agents or the Fire Underwriters' Laboratories, Chicago, Illinois, a list of acetylene gas machines which have been examined under the rules and requirements of The National Board of Fire Underwriters and which may be used for the purpose specified when installed according to directions, if not in violation of any state law or local ordinance.

The installation of an acetylene plant may affect the insurance policy covering the property, hence it is advisable to secure the consent of the insuring company. Such consent should be in writing on the policy.

These lists referred to above are revised from time to time; the factory practices are inspected and the manufacturers are under agreement to furnish for sale under the names listed only devices which are similar in all respects to samples and specifications on file at the Underwriters Laboratories.

The location of the generator should be given careful consideration. The largest measure of safety to life and property is secured by installing acetylene gas machines outside of buildings and observing strictly the rules of the National Board of Fire Underwriters. In certain







districts, local authorities prohibit the installation of these machines inside of a building unless it is used only for housing the apparatus.

The generator purchased should be of the type manufactured since the date of last examination as given in the list. The tradename or manufacturer's name should be marked on the machine. Rules of Proper Installation, Care and Maintenance of Acetylene Generators can usually be obtained from insurance agents.

A special generator house is desirable, particularly if the machine is of large capacity. The building should have double walls and be well ventilated and dry. If the winter temperatures are liable to freeze water within the generator house provision should be made to heat the house. The basement of an outhouse frequently can be utilized.

If installation is permitted in the cellar of the main building and if this location is adopted, it is advisable to provide a separate room for the generator. A machine located in the basement should not be within 15 feet of an open jet and must be placed at least 20 feet from the furnace. The generator should be so situated that it can be adjusted without the aid of artificial light. A regular time, during daylight hours only, should be set for inspection and charging the apparatus. When charging, the generator chamber of "water feed" machines\* should be carefully cleaned of all residuum and it should be at once removed from the building. Any unslaked carbide that remains in the mass should be separated and returned to the generator chamber. New carbide as required should then be added. The carbide swells or expands when it comes into contact with water. Care should be taken to see that the chamber is never filled over the specified mark.

\*The "carbide-feed" machines have largely displaced this type.



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Especial care should be taken to guard against the escape of any acetylene gas. The water supply should always be replenished when the generator chamber is charged. The residuum taken from water-feed machines should never be deposited in sewer pipes or near any inflammable material. All water tanks and water seals should be kept filled with clean water. Tests for leakage around the generator or piping should never be made with a flame and a flame should never be applied to an outlet from which the burner has been removed. No open light should be permitted near the machine.

Acetylene gas is generated by bringing water into contact with calcium carbide. Vigorous decomposition occurs, acetylene gas is given off and a residue of pure slaked lime is left. The gas is colorless and tasteless but has a characteristic pungent odor. It is lighter than air with a relative density of about .92. It is not an explosible gas unless mixed with certain proportions of air. The ideal combination to form a violent explosive mixture with air is approximately 1 foot of gas to about 12-1/2 feet of air. Explosive mixtures of less intensity will occur between the ratios of 20 to 100 and 4 to 100. Danger, however, can be considered remote since the odor of the gas would likely attract attention to the existence of a leak or open burner before a dangerous mixture could form in a room.

Fatal results from inhalation are extremely unlikely as a proportion of more than 20 parts to 100 probably would be necessary. The one-half foot acetylene burner which gives about 25 candle power consumes one-half cubic foot of gas per hour. If a steady flow of gas from a burner of this size were permitted in a room about 8 feet square by 8 feet high, in 50 hours it would produce a mixture of about 5 parts in 100.







In addition to using acetylene gas for lighting, it can be used for heating and cooking. It has a heat value about double that of ordinary coal gas. The economics of using it for this purpose depend upon the cost of carbide. Acetylene cookers, heaters and ranges with ovens are obtainable. When used for cooking, gas for the range should not be drawn from the piping for the lighting fixtures but separate lines direct from the generator should be installed.

The following are manufacturers of acetylene generators listed by the National Board of Fire Underwriters as suitable for lighting and heating:

Stationary Automatic Apparatus

|                                |                         |
|--------------------------------|-------------------------|
| Brauer Acetylene Lighting Co., | Marshalltown, Iowa.     |
| Oxweld Acetylene Co.,          | Chicago, Illinois.      |
| J. B. Colt Co.,                | New York, N. Y.         |
| St. Clair Mfg. Co.,            | Dayton, Ohio.           |
| The Hercules Mfg. Co.,         | Chattanooga, Tennessee. |
| H. W. Laun & Co.,              | Chicago, Illinois.      |
| The Alexander Milburn Co.,     | Baltimore, Maryland.    |
| Sunlight Gas Machine Co.,      | New York, N. Y.         |
| Wichita Acetylene Mfg. Co.,    | Wichita, Kansas.        |
| Carbic Mfg. Co.,               | Duluth, Minnesota.      |

The following are manufacturers of acetylene generators listed by the Board as suitable for use when installed in the ground, 30 ft. from building when possible but never less than 10 ft. removed. There must be no openings into the building and the apparatus must be protected against freezing.

|                               |                         |
|-------------------------------|-------------------------|
| General Light Co.,            | Philadelphia, Pa.       |
| Johnson Acetylene Gas Co.,    | Crawfordsville, Ind.    |
| Pennsylvania Sales Co.,       | Tunkhannock, Pa.        |
| Standard Marvel Co.,          | Salamanca, N. Y.        |
| Night Commander Lighting Co., | Jackson, Michigan.      |
| John S. Noel Co.,             | Grand Rapids, Michigan. |
| The Clifton Co.,              | Owantonna, Minnesota.   |
| New England Mfg. Co.,         | Chicago, Illinois.      |
| Oxweld Acetylene Co.,         | Chicago, Illinois.      |
| St. Clair Mfg. Co.,           | Dayton, Ohio.           |







The following firms are listed in commercial directories as manufacturing or selling acetylene lamps or lanterns.

Acetylene Gas Lamps or Lanterns.

John W. Brown, Mfg. Co.,  
Davis Acetylene Co.,  
Klemm & Co.,  
MacLeod Company,  
Alexander Milburn Co.,  
Thomas T. W. Miner,  
Royal Lamp Co., (Incandescent)  
Seiss Manufacturing Co., (Breckenridge)

Columbus, Ohio.  
Elkhart, Indiana.  
132 N. 5th Philadelphia, Pa.  
227 Bogan, Cincinnati, Ohio  
1420 Baltimore St. Balto. Md.  
821 Eagle Ave., New York City.  
Cleveland, Ohio.  
Toledo, Ohio.







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Superseded  
by 1279  
F.B

Information Series No. 45.

February 1922.

Mixing Concrete.

Concrete consists of a mixture of cement, fine and coarse aggregate, and water. For general purposes only Portland cement should be used and when a test is impractical a standard brand should be selected which is guaranteed to meet the requirements of the specifications of the American Society for Testing Materials. The cement should show no signs of caking and should be stored in a dry place in such a manner as not to come in contact with the ground nor side walls.

The fine aggregate or sand should be clean and with grains varying from  $1/4$  inch down. Fine or dirty sand and one in which all the grains are nearly of the same size makes a weak concrete. A small amount of clay (not over 10%) is not injurious especially in lean mixtures. The coarse aggregate should be a mixture of sizes, varying from  $1/4$  to  $1\frac{1}{2}$  inch depending upon the work. Ordinarily the greatest dimension of any particle should be not over  $1/4$  to  $1/6$  of the thickness of the concrete. The aggregate should be sound and clean. For general work gravel or broken stone is preferred to other aggregate. Other materials, such as broken bricks, terra cotta or slag, at times are easier to obtain, and when used with discretion will produce a satisfactory concrete. Bank run gravel should not be used without separating the fine from the coarser particles and then remixing them in such proportions as will produce a dense mixture. Cinders, or stones that do not spall when heated should be used when the concrete is to be exposed to fire. The water should be clean and free from strong acid or alkali. Sea or brackish water should not be used if possible to obtain fresh water.

In mixing concrete various quantities of materials are used depending upon the purpose for which the concrete is to be used. The following mixtures are recommended for the kind of work specified:

Rich Mixtures: Used for concrete subject to high stresses or where exceptional water tightness is desired: 1:  $1\frac{1}{2}$ : 3) i.e. one part cement, one and one half part sand and three parts gravel.

Standard Mixture: Used generally for reinforced concrete and water tight work: (1: 2: 4) i.e. one part cement, two parts sand and four parts gravel.

Medium Mixture: Used for plain concrete of moderate strength: (1: 3: 5) i.e. one part cement, three parts sand and five parts gravel.

Leaner mixtures are sometimes used after a test has proven them suitable for the work at hand.

All the material should be measured by volume and the same unit. The cubic foot is a convenient measure as a sack of cement weighing 94 pounds is considered to contain 1 cubic foot.

The following table shows the quantity of cement, sand and gravel required under average conditions, for the indicated proportions:







TABLE I

Materials for one cubic yard of rammed concrete.

| <u>Cement</u> | <u>Proportions</u> |               | <u>Sacks</u><br><u>Cement</u> | <u>Cu. Yds.</u> |               |
|---------------|--------------------|---------------|-------------------------------|-----------------|---------------|
|               | <u>Sand</u>        | <u>Gravel</u> |                               | <u>Sand</u>     | <u>Gravel</u> |
| 1             | 1                  |               | 19.20                         | 0.74            |               |
| 1             | 2                  |               | 13.48                         | 1.00            |               |
| 1             | 2½                 |               | 11.00                         | 1.01            |               |
| 1             | 3                  |               | 10.4                          | 1.16            |               |
| 1             | 1                  | 2             | 10.52                         | 0.39            | 0.78          |
| 1             | 1½                 | 3             | 7.64                          | 0.42            | 0.85          |
| 1             | 2                  | 4             | 6.04                          | 0.45            | 0.89          |
| 1             | 2½                 | 5             | 4.96                          | 0.46            | 0.92          |
| 1             | 3                  | 5             | 4.64                          | 0.52            | 0.86          |
| 1             | 3                  | 6             | 4.24                          | 0.47            | 0.94          |

Consistency. The quantity of water used in mixing has a very great influence on the strength of the concrete. An excess of water weakens the concrete while an insufficient amount prevents thorough mixing therefore only sufficient water should be used to produce a workable or plastic mixture.

Three degrees of consistency (wetness) are used in general practice, namely, wet, medium and dry. In the light of recent investigations it is thought the wet mixture of present day practice contains too much water. The following definitions are therefore recommended:

Wet Mixture: one that does not flow readily and yet can not be piled up. It is recommended for thin sections when reinforcement is closely placed.

Medium Mixture: one that is between the wet and dry mixture. This consistency is recommended for general work.

Dry Mixture: one about like damp earth. If a handful is squeezed it will retain its shape. This consistency requires thorough ramming to eliminate voids and is used when forms are to be removed immediately but should not be used where a watertight job is expected.

Forms. Forms are required to hold the concrete in place until it has attained sufficient strength to sustain itself or the initial loads to which it may be subjected. Concrete is plastic and will assume the shape of the form thus any imperfection or impression on the face of the forms will be reproduced.

Wood is commonly used for forms as it can be easily worked into different shapes, though various other materials sometimes are adapted better to special conditions. When the sides of an excavation are not likely to cave in the earth may serve as a form.

As forms must be removed they should be planned so that they can be taken down without destroying the lumber especially if the boards are to be used for sheathing or again for forms. Therefore thenailing of the boards







to the support should be only sufficient to keep them in place until the concrete has hardened. Greasing the surface next to the concrete with crude oil, soap solution, or linseed oil, will prevent the concrete adhering and facilitate removal.

Removal of Forms. The period of time after which forms may be removed varies according to conditions. Rich and dry mixtures set quickly and warm weather tends to hasten the setting of concrete. The character of the structural member and the loadings also must be considered.

Thus an unloaded wall 12 inches or more thick may be stripped of forms in from 1 to 3 days while the forms of thinner walls should remain in place from 2 to 5 days. Slab forms and the sides of beam and girder forms may be removed in from 6 to 14 days if the span is not over 7 feet. The bottom of beam and girder forms, even though of a span less than 7 feet should remain in place and braced from 10 to 14 days and even longer. Experience is the best guide to the time of removal but if there is any doubt ample time should be allowed especially in cold weather.

Good concrete can be mixed by hand or machine. Directions for operating a mixer are generally furnished with the machine. Besides the tools shown on the blue print, a bottomless box and mixing board will be necessary. The bottomless box is necessary for accurate measurement of the sand and gravel and may be of a size to contain one or more cubic feet depending upon the size of the batch to be mixed.

Table II

Inside dimensions of measuring boxes for various proportions  
(one bag batch, box 12 inches deep)

| Box for sand |                   | Box for gravel |
|--------------|-------------------|----------------|
| 1: 1: 2      | : 12 by 12 inches | : 1 by 2 feet  |
| 1: 1½: 3     | : 1 by 1½ feet    | : 1 by 3 feet  |
| 1: 2: 4      | : 1 by 2 feet     | : 2 by 2 feet  |
| 1: 2½: 5     | : 1¼ by 2 feet    | : 2 by 2½ feet |
| 1: 3: 5      | : 1½ by 2 feet    | : 2 by 2½ feet |
| 1: 3: 6      | : 1½ by 2 feet    | : 2 by 3 feet  |

When mixing by hand a mixing board 10 x 10 feet is essential and should be smooth, stiff, fairly water tight and have a 2 x 4 around the sides to keep material from being pushed off.

Directions for Hand Mixing. The mixing board should be located in convenient relation to the supply of materials and the work and should be made level. Place the sand box on the board about two feet from one of the longer sides and fill level with sand; lift the box away and spread the sand in a 3 or 4 inch layer. Spread the cement as evenly as possible on top of the sand. Two men with shovels standing on opposite sides of the pile turn the







sand and cement in such a way that the materials are thoroughly mixed. In turning the material it should not be simply dumped off the shovel but should be shaken off the ends and sides so that they will be mixed as they fall. The mass should be turned two or three times or until it is of uniform color and there are no streaks of either sand or cement. A man with a hoe or rake may assist by raking the top over as the two men turn. When the sand-cement mixture is of an uniform color it should be spread out carefully in a layer and the gravel box placed on top. The box is filled with gravel and then removed, the gravel being spread over the sand-cement mixture. The mass is soaked with about one half the quantity of water to be used, care being taken not to wash away any of the cement. The materials then should be turned over in much the same manner, as was the sand-cement except that instead of shaking them off the end of the shovel the whole load should be dumped and dragged back toward the mixer with the square end of the shovel. The wet gravel picks up the sand and cement, as it rolls over when dragged back. The mixing should be continued until the mass is uniform; water being added to the dry spots, during the mixing, until the desired consistency is obtained.

Experience counts considerably in mixing concrete with the least amount of labor; ordinarily three or four turnings are required to thoroughly mix the materials. After the final turning the concrete should be shoveled into a compact pile and then is ready for placing in the forms.

Placing Concrete. The mixed concrete should be deposited in the forms within from 20 to 30 minutes from the time the water was added to the cement as it begins to set or harden after this time. To disturb the concrete after the set has begun is risky as it will lose some of its strength, the extent of the injury depending upon the seriousness of the disturbance.

Concrete which has set before it can be placed in the forms should not be tempered or softened with water but should be discarded.

In depositing concrete in the forms care should be taken that the materials do not separate.

If the mixing is done close to the place of depositing the concrete may be shoveled into the forms directly or through a chute. If it is necessary to lift or transport the concrete, buckets and wheel barrows are convenient containers. The concrete should be deposited in horizontal layers, preferably not over 6 inches thick, and a spade or paddle should be worked up and down against the forms to push the coarse material away from the surface. The object of the spading is to eliminate impounded air that may form pockets in the mass and to insure a smoother and more impervious surface. In addition to being spaded stiff concrete should be rammed until water flushes to the surface.

Fresh concrete will not bond readily to concrete that has hardened and a seam thus may be formed that will permit water to trickle through. When bonding fresh concrete to that which has been in place for a short time it is usually sufficient to roughen the hardened surface with a pick or by other means, so as to expose the gravel or stone and clean off all loose particles. The surface should be soaked with water and given a coat of grout (a mixture of cement and water) of the consistency of cream just before the new concrete is deposited.







Care of Concrete. After the concrete has been poured care should be taken that it does not dry out too quickly and in hot weather it must be protected from the sun. Exposed surfaces and objects made of dry concrete should be sprayed thoroughly with water twice or oftener each day for a week or ten days. Sometimes surfaces are shielded with canvas, paper, boards or layers of moist sand.

Good concrete can be done in cold weather but with more difficulty and at somewhat greater cost than when the weather is warm.

The Use of Heat. Perhaps the most satisfactory method of preventing freezing of concrete is to heat the materials and enclose or cover the completed work for a few days or until most of the water has disappeared and sufficient strength has developed.







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 46.

March 1922.

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CLEANING AND REPAIRING CHIMNEY FLUES

The proper construction of chimney flues is described in Farmers Bulletin 1230, Chimneys and Fireplaces, which may be had upon request from the Division of Publications, Department of Agriculture.

As is the case with all masonry work it is sometimes necessary to rake out disintegrated mortar joints and to repoint them and, at times, to replace worn or weathered material. In chimneys this is most likely to occur around the top because of the action of the flue gases. The method of making such repairs is obvious and need not be discussed here.

Leaking flues are a source of danger and effect the efficiency of the stove, heater or fireplace. Leaks may be located by means of the smoke test described in the bulletin referred to above.

In new work the chimney should be tested with smoke before any of the masonry is enclosed by other construction as any leaks that may be found can be more easily repaired than when surrounding work renders parts of the chimney inaccessible. If the leaking joints are accessible the mortar may be raked out and the joint repointed or the entire masonry surface may be given a plaster coat of cement mortar. The only safe method of repairing a leaking flue that is without a lining, and which cannot be plastered on the outside, is to take it down and rebuild it properly.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
WASHINGTON, D. C.

March 1914.

International No. 11, 12.

REPORT OF THE COMMISSIONER OF PLANT INDUSTRY

The report of the Commissioner of Plant Industry for the year 1913, which was presented to the Senate and House of Representatives at the opening of the session in January, 1914, is herewith published in the form of a book. It contains a full and complete statement of the work of the Bureau of Plant Industry during the year, and is a valuable source of information to all those interested in the progress of the plant industry in this country.

The report is divided into two main parts, the first of which contains a general statement of the work of the Bureau, and the second of which contains a detailed statement of the work of the various divisions. The first part is divided into three sections, the first of which contains a statement of the work of the Bureau as a whole, the second of which contains a statement of the work of the various divisions, and the third of which contains a statement of the work of the various divisions. The second part is divided into two sections, the first of which contains a statement of the work of the various divisions, and the second of which contains a statement of the work of the various divisions.



Flues that leak through the joints of the lining may sometimes be improved in the following manner. Using a tightly woven cloth, such as is used in cement bags, make a pad about 1 1/2 inches thick and of a size which will fit the flue tightly. Excelsior or hoghair may be used to fill the pad. On each side of the pad place a 1 inch board cut to the shape of the flue but 2 inches less in each dimension. The boards should be well nailed together through and around the center of the pad. Attach light ropes or wires to each of the corners of each board and bring them together at the center but at least 12 inches away from the board and attach ropes long enough to permit drawing the pad up and down the flue. The short ropes or wires to the corners of the pad will tend to keep it horizontal. Place the pad in the flue at the top and draw it up and down until the flue is cleaned of soot.

With the pad drawn down to a point just above the smoke pipe entrance, pour a cement mixture of one part cement and 2 parts sand down the flue from the top using a few quarts at a time. The pad should then be pulled up and down by means of the top and bottom ropes. This operation should be continued until the entire length of the flue has been traversed several times and the open joints have been completely closed.

The cause of smoke and soot is imperfect combustion. It is usually due to one or all of the following conditions: (1) lack of sufficient air to the fire; (2) lack of proper mixture of air with furnace gases; (3) low furnace temperature; (4) too small combustion space so that the gases reach the comparatively cool furnace surface before they are completely burned, resulting in condensation of soot or tarry matter which then passes up the chimney in the form of smoke.







Creosote is the result of condensation in the chimney. It is more likely to occur when wood is used for fuel than when coal is burned and its formation in chimneys is more likely in cold climates than in sections where the weather is moderate. The percentage of water in green wood may be as high as 30 to 40 per cent, and in dry wood, 15 to 20 per cent. When wood is slowly burned, it gives off acetic and pyroligneous acid. This, in combination with water or moisture forms creosote. When the draft is strong and an active fire is maintained much of the creosote that forms will be carried off into the atmosphere. The trouble is aggravated when the fire does not burn briskly and when the flue is subjected to chilling blasts as when placed in an outside wall. The walls of the chimney being comparatively cool cause condensation of the vapors contained in the smoke. Thus the creosote condenses and runs down the flue finding its way out of any joints that are not perfectly tight. The formation of creosote is unusual in chimneys that are surrounded by warm rooms. The outer walls of a chimney in an outside wall should be at least two bricks thick and it should be lined with a good flue lining. It is permissible to place the inner side of the tile against the brick work but it is good practice to provide an air space in the brick work on the other three sides.

A simple and efficient method of clearing a chimney and smoke pipe connections of soot is to apply common salt to the fire. The sodium and chloride forming the salt are disassociated and combine with the carbon of the soot to form a substance which then passes off as a gas or drops off.

The salt should be applied to the fire after it has been put into good condition with a substantial body of hot fuel on the top. Having







been previously dried the salt should be thrown or sprinkled on the incandescent fuel bed in a quantity depending entirely on the size of the furnace or heater. About one pound at a time is considered ample for household furnaces. The dampers should be kept wide open so as to maintain the furnace temperature until the fumes have entirely disappeared or, approximately, one half hour. Additional charges of salt may be necessary to entirely remove the soot deposits. After the flue has once been thoroughly cleaned, small amounts of salt, applied every few days, will assist materially in preventing heavy deposits. It is known that layer of tarry soot  $1/16$  inch thick on boiler tubes or furnace passages will decrease their efficiency 20 per cent. A similar reduction in efficiency is to be expected in house heating furnaces.

Another method of cleaning a chimney flue of soot is to fire a revolver loaded with plank cartridges up the chimney. The flue opening, or fireplace should be closed with an old blanket or burlap to prevent soot from falling back into the room. Fires should be extinguished before this method is used.







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

INFORMATION SERIES 47

JANUARY, 1924.

COLD STORAGE REFERENCES

THE FOLLOWING PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE DEAL WITH VARIOUS PHASES OF COLD STORAGE: THE DEPARTMENT'S SUPPLY OF PHAMPLETS, FOR FREE DISTRIBUTION, OFTEN BECOMES EXHAUSTED SOON AFTER PUBLICATION AND IT IS NOT FEASIBLE TO INDICATE HERE WHICH MAY BE HAD WITHOUT CHARGE. AS LONG AS THE SUPPLY LASTS THE PUBLICATIONS LISTED BELOW MAY BE HAD FREE BY ADDRESSING THE OFFICE OF PUBLICATIONS, DEPARTMENT OF AGRICULTURE, WASHINGTON D. C. ALL OF THE DEPARTMENT PUBLICATIONS LISTED MAY BE HAD FROM THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C. FOR THE PRICES QUOTED, STAMPS NOT ACCEPTED IN PAYMENT. MOST OF THE REFERENCES MAY BE CONSULTED IN PUBLIC LIBRARIES.

U. S. DEPARTMENT OF AGRICULTURE BULLETINS.

- ✓ FARMERS' BULLETIN 4078, "HARVESTING AND STORING ICE". REVIEWS IN A GENERAL WAY, SOURCE OF ICE SUPPLY, PRINCIPLES OF STORAGE AND CUTTING. DESCRIBES FREEZING OF WATER IN METAL CANS AND TYPES OF ICE HOUSES SUITED TO FARM CONDITIONS. THIS SUPERCEDES FARMERS' BULLETIN 475, "ICE HOUSES." . . . PRICE 5¢
- ✓ FARMERS' BULLETIN 623, "ICE HOUSES AND THE USE OF ICE ON THE DAIRY FARM". DISCUSSES THE USE, COST AND QUANTITIES OF ICE REQUIRED ON THE FARM AND GIVES SHORT SPECIFICATIONS FOR VARIOUS TYPES OF ICE HOUSES, ABOUT 12 BY 16 FT. IN PLAN. SUGGESTS COOLING ROOM FOR DAIRY PRODUCTS IN THE ICE HOUSE. PRICE 5¢
- ✓ FARMERS' BULLETIN 976, "COOLING MILK & CREAM ON THE FARM". SMALL TANKS AND WATER COOLERS, PRICE 5¢.
- ✓ DEPARTMENT BULLETIN 98, "THE APPLICATION OF REFRIGERATION TO THE HANDLING OF MILK." DISCUSSES THE ACTION OF MILK UNDER COLD STORAGE CONDITIONS; ICE BUNKERS; GRAVITY BRINE SYSTEM; CONSTRUCTION AND LOCATION OF COLD STORAGE ROOMS; PRINCIPLES OF MECHANICAL REFRIGERATION - VARIOUS SYSTEMS DESCRIBED; INSULATION - EFFICIENCY OF DIFFERENT TYPES OF WALLS; APPROXIMATE COST OF SMALL PLANTS; REFRIGERATION REQUIREMENTS UNDER VARIOUS METHODS OF HANDLING MILK AS IN TRANSIT, AT CREAMERIES, ETC. PRICE 10¢.
- DEPARTMENT BULLETIN 35, "FACTORS GOVERNING THE SUCCESSFUL STORAGE OF CALIFORNIA TABLE GRAPES". A SUMMARY OF INVESTIGATIONS CONDUCTED UNDER ACTUAL COMMERCIAL CONDITIONS. PRICE 10¢.
- DEPARTMENT BULLETIN 729, "SUITABLE STORAGE FOR CERTAIN FOOD PRODUCTS". PRICE 10¢.
- DEPARTMENT BULLETIN 579, "CELERY STORAGE EXPERIMENTS". EXPERIMENTS CONDUCTED TO DETERMINE THE RESULTS OF COLD STORAGE ON CELERY. TYPES OF CRATES AND METHODS OF PILING. PRICE 10¢.
- ✓ DEPARTMENT BULLETIN 755, "COMMERCIAL PRESERVATION OF EGGS BY COLD STORAGE". PRICE 10¢.
- ✓ DEPARTMENT BULLETIN 587, "THE HANDLING AND STORAGE OF APPLES IN PACIFIC NORTH WEST". PRICE 15¢.
- ✓ DEPARTMENT BULLETIN 224, "A STUDY OF PRESERVATION OF FROZEN & DRIED EGGS IN PRODUCING SECTION". PRICE 30¢.







U. S. DEPARTMENT OF AGRICULTURE BULLETINS (CONT'D)

- DEPARTMENT BULLETIN 1072, "THE HANDLING, SHIPPING & COLD STORAGE OF BARTLETT PEARS IN THE PACIFIC COAST STATES," PRICE 5¢.
- ANIMAL INDUSTRY BULLETIN 83, "STORAGE OF CHEESE," PRICE 10¢.

SOME OF THE ABOVE BULLETINS MAKE REFERENCE TO OTHER WORKS ON THE SUBJECTS TREATED.

THE FOLLOWING MAGAZINES SPECIALIZE THE SUBJECT OF REFRIGERATION:

- "REFRIGERATING WORLD," ICE TRADE JOURNAL COMPANY, NEW YORK CITY.
- "ICE", SOUTHERN TRADE PRESS, ATLANTA, GA.
- "NATURAL ICE BULLETIN", NATURAL ICE ASSOC. OF AMERICA, NEW YORK CITY.
- "ICE & REFRIGERATION," NICKERSON & COLLINS, CHICAGO, ILL.

GENERAL INFORMATION ON REFRIGERATION INSTALLATIONS AND REQUIREMENTS ARE CONTAINED IN THE FOLLOWING PUBLICATIONS.

- MECHANICAL EQUIPMENT OF BUILDINGS, BY HARDING & WILLARD, JOHN WILEY & SONS, PUBLISHERS, 432-4TH AVE., NEW YORK CITY.
- HAND BOOK OF BUILDING CONSTRUCTION, BY HOOL AND JOHNSON, MCGRAW-HILL PUBLISHING CO., 239 W. 39TH ST., NEW YORK CITY.
- KIDDERS HAND BOOK, JOHN WILEY AND SONS, PUBLISHERS.

INFORMATION SERIES # 42, "REFRIGERATION AND ICE MAKING INSTALLATIONS," AVAILABLE FROM DIVISION OF AGRICULTURAL ENGINEERING, BUREAU OF PUBLIC ROADS, DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

ICE MACHINERY, COLD STORAGE DATA AND CONSTRUCTION DETAILS ARE COVERED IN:

- PRACTICAL COLD STORAGE BY COOPER, NICKERSON & COLLINS, PUBLISHERS, 5707 W. LAKE ST., CHICAGO, ILL.
- THE MODERN PACKING HOUSE BY F. W. WILDER, NICKERSON & COLLINS, PUB.
- COMPEND OF MECHANICAL REFRIGERATION AND ENGINEERING, BY J. E. SIEDEL, NICKERSON & COLLINS, PUBLISHERS.
- REFRIGERATION COLD STORAGE ICE MAKING BY A. J. WALLIS-TAYLOR, C. LOCKWOOD & SONS, PUBLISHERS, LONDON, ENGLAND.
- REFRIGERATION & REFRIGERATING MACHINERY, INTER LIBRARY OF TECHNOLOGY, VOL II. INTERNATIONAL CORRESPONDENCE SCHOOL, SCRANTON, PA.
- ARTIFICIAL ICE MAKING & REFRIGERATION, BY LOUIS M. SCHMIDT, PHILADELPHIA BOOK CO., PHILADELPHIA, PA.
- ELEMENTARY MECHANICAL REFRIGERATION, BY F. E. MATTHEWS, MCGRAW-HILL PUBLISHING COMPANY, 239 W. 39TH ST., N. Y. C.
- MECHANICAL REFRIGERATION, BY H. J. MACINTIRE, JOHN WILEY & SONS INC., PUB.
- POWER'S PRACTICAL REFRIGERATION BY THE EDITORIAL STAFF OF "POWER" MCGRAW-HILL PUBLISHING CO.
- BOOKS BY - THEO. AUDEL & Co., 72 - 5TH AVE., N. Y. C.

INFORMATION SERIES # 36, "ICE HOUSE CONSTRUCTION", RELATES TO THE BUILDING OF ICE HOUSES AND ICE BOXES FOR FARM USE. DATA AS TO INSULATION, QUANTITIES, ETC. AVAILABLE FROM THE DIVISION OF AGRICULTURAL ENGINEERING, BUREAU OF PUBLIC ROADS, WASHINGTON, D. C.







THE FIRMS LISTED BELOW ARE A FEW OF THOSE WHO MANUFACTURE INSULATING MATERIAL:

UNITED CORK COMPANY OF NEW YORK, LYNHURST, N. J.  
 UNION FIBRE CO., 114 UNION STREET, WINONA, MINNESOTA.  
 AMERICAN HAIR FELT COMPANY, 130 N. WELLS ST., CHICAGO, ILL.  
 CELITE PRODUCTS COMPANY, 840 MONADNOCK BLDG., " "  
 JOHNS MANVILLE, H. W. & CO., 296 MADISON AVENUE, NEW YORK CITY.

THE FOLLOWING SPECIALIZE IN COLD STORAGE DOORS:

JAMISON COLD STORAGE DOOR CO., HAGERSTOWN, MD.  
 STEVENSON COLD STORAGE DOOR COMPANY, CHESTER, PA.

THE FOLLOWING BOOKS DEAL WITH THE MACHINERY REQUIRED FOR REFRIGERATION:

THE ABSORPTION REFRIGERATING MACHINE, BY GARDNER T. VOORHEES,  
 NICKERSON & COLLINS, PUBLISHERS, 5707 W. LAKE ST., CHICAGO, ILL.  
 INDICATING THE REFRIGERATING MACHINE, BY GARDNER T. VOORHEES,  
 NICKERSON & COLLINS, PUBLISHERS.  
 REFRIGERATION MEMORANDA, BY JOHN LEVEY, NICKERSON & COLLINS, PUB.

THE FOLLOWING FIRMS HANDLE REFRIGERATION MACHINERY.

FRICK COMPANY, WAYNESBORO, PENNSYLVANIA.  
 REMINGTON MACHINERY COMPANY, WILMINGTON, DELAWARE.  
 HENRY VOGT MACHINERY COMPANY, LOUISVILLE, KY.  
 YORK MFG. COMPANY, YORK PENN.  
 DE LA VERGNE MACHINE COMPANY, 160 E. 139TH ST. NEW YORK CITY.  
 THE BRECHT COMPANY, ST. LOUIS, MO.  
 LARSEN ICE MACHINE CO., INC., 173 N. JEFFERSON ST., CHICAGO, ILL.  
 AUTOMATIC REFRIGERATOR CO., HARTFORD, CONN.  
 BUCKEYE ENGINE & FOUNDRY CO., JOLIET, ILLINOIS.  
 BUFFALO REFRIGERATING MACHINE CO., 126 LIBERTY ST., NEW YORK CITY.  
 UNITED REFRIGERATOR & ICE MACHINE CO., KENOSHA, WIS.  
 JOHNS-MANVILLE COMPANY, NEW YORK CITY.  
 BRUNSWICK REFRIGERATING CO., NEW BRUNSWICK, N. J.  
 UNITED WORKS COMPANY, SPRINGFIELD, MO.

OTHER MANUFACTURERS OF REFRIGERATING SUPPLIES AND COLD STORAGE DEALERS CAN BE HAD BY CONSULTING COMMERCIAL DIRECTORIES OR -

"ICE & REFRIGERATION BLUE BOOK" PUBLISHED BY NICKERSON & COLLINS.  
 "STORAGE RATE GUIDE", CONTAINS STORAGE RATES ON GENERAL MERCHANDISE, PUBLISHED BY NICKERSON & COLLINS.

"MOHUN ON WAREHOUSEMEN", BY BARRY MOHUN, IS A COMPILATION OF WAREHOUSE LAWS AND DECISION, PUBLISHED BY NICKERSON & COLLINS.

WHILE THE FIRMS LISTED ABOVE ARE BELIEVED TO BE RELIABLE IT SHOULD NOT BE ASSUMED THAT THEIR MENTION IMPLIES ANY PARTICULAR ENDORSEMENT BY THE DEPARTMENT OF EITHER THE PRICES OR QUALITY OF THEIR PRODUCTS.







COULD THE HISTORY OF THE PLOUGH, THE TYPE AND PIONEER OF ALL OTHER IMPLEMENTS OF HUSBANDRY, BE TRACED FROM ITS ORIGIN, IT WOULD PROBABLY BE FOUND THAT FEW AGRICULTURAL UTENSILS HAVE UNDERGONE GREATER MODIFICATIONS, OR BEEN MORE SLOWLY IMPROVED THAN THE PLOUGH. ORIGINALLY, NOTHING MORE THAN THE RUDE BRANCH OF A TREE, WITH ITS CLEFT AND CURVED END SHARPENED TO SCRATCH A FURROW FOR THE SEED, POSSIBLY, AS SUGGESTED BY THE INGENIOUS TULL, IN IMITATION OF THE TILLAGE EFFECTED BY SWINE, THE INSTRUMENT APPEARS AT THIS TIME TO HAVE BEEN BROUGHT AS NEARLY TO PERFECTION AS IT IS POSSIBLE TO ATTAIN. THE PRIMITIVE PLOUGH, A "MERE WEDGE WITH A SHORT BEAM AND CROOKED HANDLE," BECAME IN TIME FITTED WITH A MOVABLE SHARE OF WOOD, STONE, COPPER, OR IRON, WROUGHT TO SUITABLE SHAPE, AS WE FIND IT IN THE HANDS OF OUR SAXON ANCESTORS. TO THIS A RUDE WOODEN MOULD-BOARD TO TURN THE FURROW WAS AFTERWARD ADDED, AND WITH VARIOUS IMPROVEMENTS IN SHAPE, CONTINUED IN USE UNTIL NEAR THE PRESENT TIME.

WHAT WAS ITS FORM OR EFFICIENCY IN THE DAYS WHEN ELISHA WAS SUMMONED FROM PLOUGHING WITH TWELVE YOKE OF OXEN, TO ASSUME THE MANTLE AND FUNCTIONS OF THE HEBREW PROPHET, MAY NOT BE QUITE APPARENT, BUT THE PLOUGH WAS CERTAINLY HUNDREDS OF YEARS IN REACHING THE IMPERFECT STATE ABOVE DESCRIBED, AND WAS SEVERAL HUNDRED MORE IN APPROXIMATING ITS PRESENT IMPROVED CONDITION. IN THE MIDDLE OF THE LAST CENTURY THE PLOUGHS OF SOUTHERN EUROPE HAD BEEN LITTLE IMPROVED, AND WERE STILL DESTITUTE OF A COULTER, AS IN THE OLD ROMAN PLOUGH OF THE DAYS OF VIRGIL AND COLUMELLA. IT HAS RECEIVED FEW MODIFICATIONS THERE DOWN TO THIS TIME. EVEN IN ENGLAND, AT THAT PERIOD, THE PLOUGH WAS AN EXCEEDINGLY RUDE AND CUMBERSOME AFFAIR COMPARED WITH THE BEST NOW IN USE. IT WAS NO UNCOMMON THING IN PARTS OF THE ISLAND THIRTY YEARS AGO TO SEE FROM THREE TO FIVE HORSES IN LIGHT SOILS, AND IN HEAVY ONES SOMETIMES, AS MANY AS SEVEN ATTACHED TO A PLOUGH, WHICH TURNED ABOUT THREE-QUARTERS OF AN ACRE PER DIEM. THE OLD SCOTCH PLOUGH WAS STILL WORSE, AND IN SCOTLAND, WHERE AGRICULTURAL MACHINERY IS NOW MOST PERFECT, NO INSTANCE WAS KNOWN OF PLOUGHING WITH LESS THAN FOUR HORSES. THE USUAL NUMBER WAS SIX HORSES, OR FOUR HORSES AND TWO OXEN, AND SOMETIMES AS MANY AS TEN OR TWELVE WERE YOKED TO IT, EACH REQUIRING A DRIVER. WILLIAM DAWSON, SOON AFTER 1760, INTRODUCED THE CUSTOM OF PLOUGHING WITH TWO HORSES ABREAST WITH LINES.\*

ALTHOUGH THE SWING-PLOUGH IS BELIEVED TO HAVE BEEN THE EARLIEST USED IN GREAT BRITAIN, ONE AND TWO WHEEL PLOUGHS - LONG USED ON THE CONTINENT - WERE MOST IN FAVOR. TURN-WREST PLOUGHS, DRILL, DRAIN, AND TRENCHING PLOUGHS, AND OTHERS ADAPTED TO DIFFERENT USES, WERE EMPLOYED IN CONSIDERABLE VARIETY.

A CAPITAL IMPROVEMENT IN THE PLOUGH WAS THE INVENTION OF THE IRON MOULD-BOARD AND LANDSIDE. AN APPROACH TO THIS WAS MADE BY JOSEPH FOLJAMBRE, OF ROTHERHAM, ENGLAND, WHO IN 1720 TOOK OUT THE FIRST PATENT OF THE KIND RECORDED. IT WAS FOR A MOULD-BOARD AND LANDSIDE OF WOOD SHEATHED WITH IRON PLATES, THE SHARE AND COULTER BEING MADE OF WROUGHT IRON WITH STEEL EDGES. ONE OF THESE PATENT OR ROTHERHAM PLOUGHS - AS ALL SIMILAR ONES WERE CALLED FOR MANY YEARS - WAS IMPORTED AND USED FOR SOME TIME WITH MUCH SATISFACTION BY GENERAL WASHINGTON, BUT, BECOMING WORN, OUR PLOUGH-WRIGHTS WERE UNABLE TO REPAIR IT. THE PLOUGHS USED IN NEW ENGLAND EARLY IN THIS CENTURY, AND MORE RECENTLY IN THE SOUTH, WERE OF SIMILAR CONSTRUCTION. ABOUT THE YEAR 1740 JAMES SMALL, OF BERWICKSHIRE, IN SCOTLAND,

\* McCulloch's STATISTICS OF BRITISH EMPIRE,







FIRST INTRODUCED THE CAST-IRON MOULD-BOARD, STILL USING WROUGHT IRON SHARES. DURING FIFTY YEARS HE CONTINUED TO MANUFACTURE AND IMPROVE THE SCOTCH SWING-PLOUGH, WHICH, SINCE MADE WHOLLY OF IRON, HAS LONG BEEN REGARDED AS THE BEST IN USE IN ENGLAND. IN 1785 ROBERT RANSOME, OF IPSWICH, INTRODUCED CAST-IRON SHARES, AND ABOUT 1803 MADE IMPROVEMENTS STILL IN USE, BY MAKING THE CUTTING EDGES OF CHILLED IRON HARDER THAN STEEL, BY CASTING THEM IN MOULDS UPON BARS OF COLD IRON. THE MAKING OF THE FIRST IRON PLOUGH HAS BEEN ATTRIBUTED TO WILLIAM ALLAN, A FARMER OF LANARKSHIRE, IN SCOTLAND, IN 1804, BUT AN IRON PLOUGH WAS PRESENTED TO THE SOCIETY OF ARTS IN LONDON AS EARLY AS 1773, BY A MR. BRAND. THE CAST-IRON PLOUGH WAS INTRODUCED SOON AFTER. LIKE MOST OTHER IMPROVEMENTS IN RUSTIC MACHINERY, THE IRON PLOUGHS, THOUGH DOING MUCH SUPERIOR WORK AT LESS THAN HALF THE EXPENSE OF THE CLUMSY WOODEN PLOUGH OF THAT DATE, CAME TARDILY INTO USE. IT IS SAID THAT SIR ROBERT PEEL, IN 1835, HAVING PRESENTED A FARMERS' CLUB WITH TWO IRON PLOUGHS OF THE BEST CONSTRUCTION, FOUND ON HIS NEXT VISIT THE OLD PLOUGHS WITH WOODEN MOULD-BOARDS AGAIN AT WORK; "SIR," SAID A MEMBER, "WE TRIED THE IRON, AND BE ALL OF ONE MIND, THAT THEY MADE THE WEEDS GROW." \* A SIMILAR PREJUDICE OPPOSED THE INTRODUCTION OF THE FIRST CAST-IRON PLOUGH IN AMERICA, PATENTED IN 1797 BY CHARLES NEWDOLD, OF NEW JERSEY, WHO, AFTER SPENDING, AS HE ALLEGES, \$30,000 IN TRYING TO GET IT INTO USE, ABANDONED THE ATTEMPT, THE FARMERS DECLARING THAT IRON PLOUGHS POISONED THE SOIL AND PREVENTED THE GROWTH OF CROPS.

THE PLOUGH HAS RECEIVED MANY IMPROVEMENTS AT THE HANDS OF AMERICANS, AND HAS BECOME AN ARTICLE OF FREQUENT EXPORTATION, WHILE EVEN IN GREAT BRITAIN THE PLOUGHS NOW USED ARE GENERALLY MADE AFTER AMERICAN MODELS. THE YEAR 1617 IS MENTIONED BY AN EARLY ANNALIST AS THE "REMARKABLE PERIOD OF THE FIRST INTRODUCTION OF THE LABOR OF THE PLOUGH" IN VIRGINIA. IN 1625 WE FIND THE DUTCH COLONY ON THE HUDSON SUPPLIED WITH "ALL SORTS OF SEEDS, PLOUGHS, AND AGRICULTURAL IMPLEMENTS," TO WHICH IN 1662 WAS ADDED A FIRST-CLASS WHEEL-PLOUGH, WITH ITS PULLEYS, ETC., AT A COST OF SIXTY FLORINS. IN 1637 THE COLONY OF MASSACHUSETTS CONTAINED BUT THIRTY PLOUGHS, AND CONNECTICUT PROBABLY LESS THAN ONE-THIRD THE NUMBER. NEVERTHELESS, THE SAME YEAR A RESIDENT OF SALEM WAS PROMISED AN ADDITION OF TWENTY ACRES TO HIS ORIGINAL GRANT IF HE WOULD "SET UP PLOUGHING." WE INVOLUNTARILY THINK OF THE STEAM-PLOUGH WHEN WE READ THAT ANOTHER CITIZEN OF THAT TOWN IN THE FOLLOWING YEAR WAS ALLOWED MORE LAND BECAUSE HE HAD "NOT SUFFICIENT GROUND TO MAINTAIN A PLOUGH" ON HIS FARM OF 300 ACRES. OWING TO THE SCARCITY OF MECHANICAL LABOR, MOST OF THE PLOUGHS AND OTHER FARM UTENSILS WERE FOR A LONG TIME MADE ON THE FARM, WITH THE AID OF THE NEAREST SMITH. THE CASTING OF PLOUGH-IRONS WAS DONE AT NEARLY EVERY SMALL FOUNDRY. THEIR MAKE WAS, OF COURSE, CLUMSY AND IN-EFFICIENT. AMONG THE KINDS STILL REMEMBERED BY MANY WAS THE CARY PLOUGH, WITH CLUMSY WROUGHT-IRON SHARE, WOODEN LANDSIDE AND STANDARD, AND WOODEN MOULD-BOARD PLATED OVER WITH SHEET-IRON OR TIN, AND WITH SHORT UPRIGHT HANDLES, REQUIRING A STRONG MAN TO GUIDE IT. THE BAR-SHARE PLOUGH WAS ANOTHER FORM STILL REMEMBERED BY MANY FOR ITS RUDELY FITTED WOODEN MOULD-BOARD AND COULTER, AND IMMENSE FRICTION FROM THE ROUGH IRON BAR WHICH FORMED THE LANDSIDE. THE BULL-PLOUGH WAS SIMILAR IN FORM, BUT WITHOUT A COULTER. EVEN THE SHOVEL-PLOUGH, NOT UNLIKE THE RUDE INSTRUMENT STILL

\* PHILIPS' HISTORY OF PROGRESS IN GREAT BRITAIN.







USED BY THE CHINESE, MAY BE REMEMBERED BY SOME, AND WAS IN COMMON USE IN THE COTTON STATES A FEW YEARS SINCE. AS EARLY AS 1765 THE LONDON SOCIETY OF ARTS AWARDED A GOLD MEDAL TO BENJAMIN GALE, OF KILLINGWORTH, CONNECTICUT, FOR A DRILL-PLOUGH, THE INVENTION OF WHICH WAS CLAIMED BY BENONI HILLIARD, OF THE SAME PLACE. THE FIRST PATENT TAKEN OUT AFTER THE ORGANIZATION OF THE UNITED STATES PATENT OFFICE WAS IN JUNE, 1797, BY CHARLES NEWBOLD, OF BURLINGTON, NEW JERSEY, FOR THE CAST-IRON PLOUGH ALREADY MENTIONED, WHICH COMBINED THE MOULD-BOARD, SHARE AND LANDSIDE, ALL IN ONE CASTING. HE AFTERWARDS SUBSTITUTED WROUGHT-IRON SHARES, OBJECTIONS HAVING BEEN MADE TO THE CAST IRON PROBABLY BECAUSE NOT CHILL-HARDENED. HE DID NOT SUCCEED IN GETTING THEM INTO PERMANENT FAVOR, ALTHOUGH CAST-IRON PLOUGHS WERE ADVERTISED FOR SALE IN NEW YORK IN THE YEAR 1800, BY PETER J. CURTENIUS, A LARGE IRON FOUNDER OF THE CITY. NEWBOLD WAS PAID ONE THOUSAND DOLLARS BY DAVID PEACOCK, A FELLOW-TOWNSMAN, WHO, IN APRIL, 1807, PATENTED A MODIFICATION OF THE IRON PLOUGH, HAVING THE MOULD-BOARD AND LANDSIDE CAST SEPARATE, WITH A WROUGHT-IRON STEEL-EDGED SHARE ATTACHED.

AS EARLY AS 1798 MR. JEFFERSON ALSO EXERCISED HIS MECHANICAL TASTES IN IMPROVING THE MOULD-BOARD OF PLOUGHS, WHICH HE AFTERWARDS ADAPTED TO AN IMPROVED PLOUGH SENT HIM BY THE AGRICULTURAL SOCIETY OF THE DEPARTMENT OF THE SEINE, IN FRANCE. HIS SON-IN-LAW, MR. RANDOLPH, WHOM MR. JEFFERSON THOUGHT PROBABLY THE BEST FARMER IN VIRGINIA, INVENTED A SIDE-HILL PLOUGH, ADAPTED FOR THE HILLY REGIONS OF THAT STATE, AND DESIGNED TO TURN HORIZONTALLY, IN THE SAME DIRECTION, THE SIDES OF STEEP HILLS, WHICH, IN NORTHERN EUROPE, WAS EFFECTED BY A SHIFTING MOULD-BOARD, CONSTITUTING THE VARIETY CALLED TURN-WREST PLOUGHS. COLONEL RANDOLPH'S PLOUGH WAS MADE WITH TWO WINGS WELDED TO THE SAME BAR, WITH THEIR PLANES AT RIGHT ANGLES TO EACH OTHER, SO THAT BY TURNING THE BAR, ADJUSTED AS AN AXIS, EITHER WING COULD BE LAID FLAT ON THE GROUND, WHILE THE OTHER, STANDING VERTICALLY, SERVED AS A MOULD-BOARD. MR. JEFFERSON ADVOCATED AN ADHERENCE TO SCIENTIFIC PRINCIPLES IN THE CONSTRUCTION OF THE PLOUGH. PERHAPS THE FIRST ATTEMPT TO CARRY OUT THESE SUGGESTIONS WAS MADE BY ROBERT SMITH, OF PENNSYLVANIA, WHO, IN MAY, 1800, TOOK OUT THE FIRST PATENT FOR THE MOULD-BOARD ALONE OF A PLOUGH. IT WAS OF CAST IRON, AND OF IMPROVED FORM, THE PRINCIPLES OF WHICH WERE PUBLISHED BY HIM. IN JULY, 1814, JETHRO WOOD, OF SCIPIO, NEW YORK, WAS GRANTED A PATENT FOR A CAST-IRON PLOUGH HAVING THE MOULD-PLATE, SHARE, AND LANDSIDE CAST IN THREE PARTS. THE MOULD-PLATE COMBINED THE MECHANICAL PRINCIPLES OF THE WEDGE AND SCREW IN RAISING AND INVERTING THE FURROW-SLICE. IT BECAME THE FOUNDATION OF MANY PATENTED IMPROVEMENTS OF LATER DATE, AND OF A HAND-SOME COMPETENCE TO THE INVENTOR, WHO, IN 1819, RECEIVED A SECOND PATENT, WHICH WAS RENEWED BY ACT OF CONGRESS IN 1832.

A SERIES OF IMPROVEMENTS IN THE CAST-IRON PLOUGHS WAS COMMENCED ABOUT 1810 BY JOSIAH DUCHER, OF NEW YORK, WHICH WERE PATENTED IN 1822. SOME OF THEM ARE STILL RETAINED IN USE. TWO IMPROVEMENTS IN THE CAST-IRON PLOUGH, DESIGNED TO MAKE IT EASIER OF DRAUGHT, WERE COVERED BY LETTERS PATENT ISSUED IN APRIL, 1821, TO A. L. & E. A. STEVENS, OF HOBOKEN, NEW JERSEY. ONE OF THESE WAS FOR HARDENING THE CUTTING-EDGES AND PARTS EXPOSED TO WEAR BY COLD-CHILLING THEM. FOUR OTHER PATENTS ON THE CAST-IRON PLOUGH WERE GRANTED THE SAME YEAR. MUCH CREDIT IS ALSO DUE TO JOEL NOURSE, OF MASSACHUSETTS, AND HIS PARTNERS, FOR IMPROVING AND PERFECTING THE CAST-IRON PLOUGH, WHICH WAS COMPARATIVELY A RUDE INSTRUMENT, IN







LIMITED DEMAND, AS LATE AS 1836, WHEN THEY COMMENCED THE MANUFACTURE OF AGRICULTURAL IMPLEMENTS AT WORCESTER. THE SALE OF TWENTY THOUSAND PLOUGHS IN A SINGLE YEAR BY THIS FIRM, WITHIN TWENTY YEARS AFTER THEY COMMENCED BUSINESS, INDICATED THE INCREASED DEMAND FOR PLOUGHS, WHICH THEY WERE ABLE TO SUPPLY, OF ONE HUNDRED AND FIFTY DIFFERENT FORMS AND SIZES. AMONG THESE WERE SUBSOIL PLOUGHS ADAPTED TO TEAMS OF FROM ONE TO SIX HORSES, THE FIRST IMPLEMENT OF THAT KIND IN THE UNITED STATES HAVING BEEN IMPORTED BY THEM IN 1840 FROM SCOTLAND, AND SUBSEQUENTLY IMPROVED BY MAKING IT MORE SIMPLE, LIGHT, AND CHEAP IN CONSTRUCTION. AMERICAN HILL-SIDE PLOUGHS ARE NOW EXPORTED TO GREAT BRITAIN. THE NUMBER OF PATENTS GRANTED FOR PLOUGHS PREVIOUS TO 1830 WAS 124, AND UP TO 1848 HAD REACHED BETWEEN THREE AND FOUR HUNDRED.

A DISTINCTIVE FEATURE IN AMERICAN PLOUGHS IS THEIR GREAT SIMPLICITY, LIGHTNESS OF DRAUGHT, NEATNESS, AND CHEAPNESS, WHICH IS OFTEN IN STRIKING CONTRAST WITH THOSE OF FOREIGN MAKE. THIS ECONOMY OF POWER ATTRACTED ATTENTION TO TWO PLOUGHS SENT, IN 1815, TO ROBERT BARCLAY, OF BURY HILL, NEAR DORKING, IN ENGLAND, BY JUDGE PETERS, PRESIDENT OF THE PHILADELPHIA SOCIETY OF AGRICULTURE, THE SEAL OF WHICH SOCIETY, BY THE WAY, BEARS AS A DEVICE A REPRESENTATION OF THE PLOUGH OF THE DATE OF 1785. THE PLOUGHS REFERRED TO WERE MADE BY ORDER OF MR. PETERS, TO COMBINE THE BEST PRINCIPLES AND FORMS OF AMERICAN PLOUGHS, AND WHEN TESTED IN AUGUST OF THAT YEAR AGAINST THE BEST ENGLISH PLOUGHS, WERE FOUND TO DO THE WORK QUITE AS WELL AND AS EASILY WITH TWO HORSES AS THE OTHER DID WITH FOUR. AMERICAN PLOUGHS OBTAINED FAVOR WITH ENGLISH FARMERS FOR SUBSTANTIALLY THE SAME CHARACTERISTICS, NAMELY, "EXTRAORDINARY CHEAPNESS AND LIGHTNESS OF DRAUGHT," AT THE TRIAL OF PLOUGHS AT HOUNSLOW DURING THE GREAT EXHIBITION IN 1851.

IN THE EARLY PART OF THIS CENTURY THE MANUFACTORIES OF PLOUGHS IN THE UNITED STATES WERE FEW AND SMALL IN SIZE. IT HAS SINCE BECOME AN IMPORTANT BRANCH OF THE AGRICULTURAL IMPLEMENT BUSINESS. PLOUGHS WERE MADE AND EXPORTED IN CONSIDERABLE QUANTITY AT ENFIELD, CONNECTICUT, PREVIOUS TO 1819. ONE OF THE LARGEST ESTABLISHMENTS IN THIS OR ANY COUNTRY, DEVOTED CHIEFLY TO PLOUGH-MAKING, WAS ESTABLISHED IN PITTSBURG, PENNSYLVANIA, (1829) IN 1836 IT MADE BY STEAM-POWER ONE HUNDRED PLOUGHS DAILY, OF PATTERNS ADAPTED LARGELY FOR THE LOWER MISSISSIPPI, AND COTTON AND PRAIRIE LANDS OF THE SOUTH AND WEST. THE IRON-CENTRE PLOUGH, AND HILL-SIDE REVOLVING BEAM-PLOUGH, WERE AMONG THE VALUABLE MODIFICATIONS ORIGINATED BY THE CONCERN WHICH NOW MAKES ALSO THE STEEL-PLOUGHS SO VALUED IN PRAIRIE FARMING. ANOTHER STEAM-PLOUGH FACTORY IN PITTSBURG MADE IN 1836 ABOUT 4,000 PLOUGHS ANNUALLY, INCLUDING WOOD AND CAST-IRON PLOUGHS, AND A GREAT VARIETY OF OTHER KINDS. THESE TWO FACTORIES, TOGETHER, MADE 34,000 PLOUGHS YEARLY, OF THE VALUE OF \$174,000. THERE ARE SEVERAL OTHER EXTENSIVE AND NUMEROUS SMALLER MANUFACTORIES THROUGHOUT THE COUNTRY, PARTICULARLY IN THE WESTERN STATES, IN WHICH PLOUGH-MAKING IS CARRIED ON AS A SPECIALTY. IT FORMS, HOWEVER, A BRANCH OF THE GENERAL MANUFACTURE OF AGRICULTURAL IMPLEMENTS. IN THE BEST CONDUCTED OF THESE, MACHINERY IS EXTENSIVELY EMPLOYED, AND SUCH A DIVISION OF LABOR AS TO SECURE GREAT SPEED AND PERFECTION OF WORKMANSHIP, AS WELL AS A GREAT REDUCTION OF THE COST. FOR EACH SIZE AND PATTERN OF PLOUGH, THE SEVERAL PARTS SUBJECT TO WEAR ARE MADE ALL ALIKE, SO AS TO FIT ANY PLOUGH OF THAT CLASS, AND ALLOW IT TO BE READILY REPLACED WITHOUT THE AID OF THE PLOUGH-RIGHT. SULKY-PLOUGHS, WITH A SEAT FOR THE DRIVER, AND GANG-PLOUGHS, CUTTING SEVERAL FURROWS AT A TIME, HAVE BEEN INTRODUCED, BUT HAVE NOT PROVED GENERALLY SATISFACTORY. ROLLING OR WHEEL COULTERS HAVE, IN MANY CASES, TAKEN THE PLACE OF THE OLD STANDING COULTER. MANY PLOUGHS NOW HAVE A HOOK ATTACHED FOR TURNING THE WEEDS UNDER THE FURROW, AN IMPORTANT IMPROVEMENT FOR PRAIRIE FARMS, WHERE WEEDS, LIKE OTHER VEGETATION, ARE LUXURIANT.







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LIME BURNING

LIME BURNING IS THE PROCESS OF CONVERTING LIMESTONE INTO LIME BY MEANS OF HEAT. LIMESTONE IS A ROCK VARYING IN COMPOSITION FROM PURE CALCIUM CARBONATE OR CALCITE TO A MIXTURE OF 54% CALCIUM CARBONATE WITH 45% MAGNESIUM CARBONATE. WHILE ALMOST ANY PROPORTION OF THESE CONSTITUENTS (BETWEEN THE LIMITS INDICATED) CAN BE FOUND IT IS MORE COMMON TO FIND THE STONE EITHER HIGH IN CALCIUM CARBONATE OR HIGH IN MAGNESIUM CARBONATE. BESIDES THESE TWO CONSTITUENTS, SILICA, IRON, ALUMINA AND ALKALIES COMMONLY EXIST AS IMPURITIES. WHEN THE STONE IS RAISED TO A SUFFICIENTLY HIGH TEMPERATURE AND KEPT THERE FOR A SUFFICIENT LENGTH OF TIME, THE CARBONATES ARE DISSOCIATED AND CARBON DIOXIDE IS GIVEN OFF AS A GAS, THE STONE LOSING ABOUT HALF ITS WEIGHT.

THE CHEMICAL COMPOSITION OF THE LIME DEPENDS UPON THAT OF THE STONE FROM WHICH IT WAS MADE AND LIMES ARE ACCORDINGLY DIVIDED COMMERCIALY INTO:

|                                    |                  |
|------------------------------------|------------------|
| HIGH CALCIUM LIMES OR THOSE WITH   | 0 TO 5% MAGNESIA |
| MAGNESIUM LIMES OR THOSE WITH      | 5 TO 25% "       |
| DOLOMITE LIMES OR THOSE WITH       | 25 TO 45% "      |
| SUPER DOLOMITE LIMES OR THOSE WITH | OVER 45% "       |

THE COMPOSITION WHICH A LIME SHOULD HAVE FOR ANY GIVEN PURPOSE IS A MUCH MOOTED QUESTION. THE PRESENCE OF RATHER A LARGE AMOUNT OF IMPURITIES IN THE STONE IS PERMISSIBLE, EXCEPT WHERE A FINISHING LIME OR A PARTICULAR GRADE OF CHEMICAL LIME IS TO BE MADE.

THE CHEMICAL AND PHYSICAL PROPERTIES OF LIMESTONE INFLUENCES THE COST OF BURNING. IT GENERALLY REQUIRES LESS HEAT TO BURN MAGNESIUM THAN HIGH CALCIUM LIMESTONES ALSO THE GREATER THE PROPORTION OF IMPURITIES, THE MORE EASILY IS THE LIMESTONE OVERBURNED. ABOUT 2% OF SILICA WILL NOT EFFECT THE BURNING OF THE STONE BUT THE ALUMINA AND IRON CONTENT SHOULD NOT BE OVER 1/2 TO 1 %. LESS HEAT IS REQUIRED TO BURN A FINE GRAIN DENSE STONE THAN ONE WHICH IS COARSELY CRYSTALLINE AND POROUS. ALSO LARGE STONES WILL TAKE LONGER TO BURN THAN SMALL ONES. COARSELY CRYSTALLINE STONES ESPECIALLY IF VERY PURE ARE LIABLE TO FALL TO PIECES IN THE KILN THUS REDUCING THE AMOUNT OF LIME IN LUMP FORM.

THE AMOUNT OF HEAT REQUIRED DEPENDS UPON THE CHARACTER OF THE STONE AND VARIES FROM 1454° F TO 2192° F. THE BURNING MAY BE DONE AT A HIGH TEMPERATURE MAINTAINED FOR A SHORT TIME OR A LOWER TEMPERATURE FOR A LONGER TIME. THE ACTIVITY OF THE IMPURITIES BECOMES NOTICEABLE AT THE HIGHER TEMPERATURES THEREFORE THE LOWER THE TEMPERATURE AT WHICH THE LIME IS BURNED THE BETTER WILL BE ITS QUALITY. THE MINIMUM TEMPERATURE REQUIRED CAN BE LOWERED BY THE INTRODUCTION OF STEAM INTO THE KILN. SOME STEAM IS GENERATED DURING THE COMBUSTION OF WOOD AND TEMPERATURES ARE LOWER IN KILNS IN WHICH THIS FUEL IS BURNED, HENCE WOOD-BURNED LIME GENERALLY COMMANDS A HIGHER PRICE THAN THAT BURNED WITH COAL.



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THE SECRETARY OF THE ARMY  
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DIRECTIONS FOR BUILDING A LIME KILN.1ST METHOD.

POLES AND SLABS ARE PLACED LENGTHWISE ON THE GROUND MAKING A LAYER 30 FEET LONG AND 16 FEET WIDE. THE LARGEST POLES 8 TO 10 INCHES IN DIAMETER ARE USED IN THE OUTSIDE ROWS TO MAKE A MORE STABLE FOUNDATION. THE SMALLER POLES AND SLABS ARE PLACED BETWEEN THE LARGE OUTSIDE POLES BUT A CLEAR STRIP OR CHANNEL WITHOUT WOOD 2 FEET WIDE IS LEFT EXTENDING THE LENGTH OF THE FIRST LAYER OF POLES. THIS STRIP IS FILLED WITH SMALL WOOD AND KINDLING; LIKEWISE CHINKS BETWEEN THE POLES AND SLABS ARE FILLED WITH FINE WOOD AND CORN STALKS.

OVER THIS FIRST LAYER OF WOOD IS SPREAD A LAYER OF FINE COAL TO A DEPTH OF TWO INCHES. ON TOP OF THE COAL IS PLACED A 4 OR 5 INCH LAYER OF LIMESTONE, ABOUT THE SIZE OF A MAN'S HEAD OR SMALLER. ANOTHER LAYER OF COAL IS THEN ADDED AND THIS FOLLOWED BY A LAYER OF LIMESTONE 12 TO 14 INCHES THICK. ALTERNATE LAYERS OF STONE AND COAL ARE ADDED UNTIL THE PILE IS 7 OR 8 FEET HIGH. THE SIDES ARE GRADUALLY DRAWN IN MAKING THE PILE SOMEWHAT PYRAMIDAL IN SHAPE AND DRAWING IT TO A PEAK. AS MUCH COAL AS THE CREVICES WILL HOLD IS THEN SHOVELED ON AND THE KILN IS READY FOR FIRING.

START THE FIRE ON THE WINDWARD END NEAR THE MIDDLE WHERE THE STRIP OF KINDLING WAS PLACED. THE FIRE WILL BEGIN TO BURN GRADUALLY. AS THE FIRE BURSTS OUT FROM THE SIDES (WHICH WILL HAPPEN IN A DAY OR TWO) IT IS SMOTHERED, BY SHOVELING DIRT OVER THE PILE, AS THE FIRE MUST NOT BURN TOO RAPIDLY. THE KILN SHOULD BURN FOR ABOUT TWO WEEKS. WHEN COOL THE DIRT IS REMOVED IN ORDER TO ALLOW THE RAINS TO SINK IN AND SLAKE THE LIME AFTER WHICH IT IS READY TO BE USED ON THE LAND.

IT IS ESTIMATED THAT ONE MAN, IN TWO WEEKS, BY USING A SMALL AMOUNT OF DYNAMITE CAN QUARRY SUFFICIENT STONE FOR THIS KILN. ABOUT 453 BU. OR  $16\frac{1}{2}$  TONS OF LIME-BURNER'S COAL AND 4 LOADS OF WOOD WILL BE REQUIRED. THE LABOR OF MAKING AND TENDING THE KILN WILL BE ABOUT EQUIVALENT TO 1 MAN'S LABOR FOR  $2\frac{1}{2}$  WEEKS.

2ND METHOD (SEE ATTACHED PRINT # 1826)

SELECT A SUITABLE LOCATION NEAR THE QUARRY AND PREFERABLY ON THE SIDE OF A HILL. MAKE AN EXCAVATION 10 FEET INTO THE HILL AND 7 FEET DEEP. MAKE THE WIDTH OF THE KILN 8 FEET AT ITS GREATEST BREADTH, SLOPING GENTLY ON THE BOTTOM. DIG A TRENCH 18 INCHES WIDE AND 12 INCHES DEEP THROUGH THE CENTER AT THE BASE OF THE KILN. PLACE OLD PIECES OF CASTINGS ACROSS THE TRENCH TO SERVE AS A GRATE. BUILD THE FRONT AND SIDE WALLS OF THE KILN LIKE A RETAINING WALL. SOMETTIMES THE REAR WALLS ARE BUILT OF ROCK BUT USUALLY NO WALL IS BUILT, AS THE SIDES OF THE HILL ANSWER THE PURPOSE. THE GENERAL PLAN OF THE KILN IS MADE OVAL BOTH AT THE BASE AND TOP.







FILLING THE KILN. OVER THE GRATE, IN THE CENTER, PLACE A LAYER OF COAL OF SUFFICIENT SIZE NOT TO PASS THROUGH THE OPENINGS. PLACE LIMESTONE ROCK, VARYING FROM 6 TO 12 INCHES IN DIAMETER, ON TOP OF THIS LAYER OF COAL.. THE KILN IS THEN FILLED BY PLACING ALTERNATE LAYERS OF COAL AND ROCK. LEAVE AN OPENING IN THE REAR AT THE TOP LARGE ENOUGH TO SERVE THE PURPOSE OF A FLUE. WHEN THE KILN HAS BEEN FILLED COVER IT WITH A LAYER OF FLAT ROCKS AND CLOSE THE FRONT WITH A ROCK AND SEAL WITH MUD. PLACE SUFFICIENT KINDLING IN THE TRENCH TO IGNITE THE COAL. LET THE FIRE BURN FOR FROM 2 TO 3 DAYS AND ALLOW 3 TO 5 DAYS FOR COOLING.

ONE MAN'S TIME WILL BE REQUIRED FOR FROM 8 TO 10 DAYS TO BUILD AND LOAD THE KILN WHILE ABOUT 100 BU. OF LIME-BURNER'S COAL WILL BE USED.

### LIME.

LIME (CALCIUM OXIDE OR QUICK LIME) AS IT COMES FROM THE KILN IS A WHITE SOLID. WHEN MADE FROM LIMESTONE ROCK THE LIME IS GENERALLY IN LUMPS. SOFT LIMESTONES AND SHELLS GENERALLY FALL TO PIECES IN THE KILN. SUCH FINE LIME IS AS GOOD FOR ALL PURPOSES AS LUMP LIME, IS EASIER TO HANDLE AND WILL KEEP BETTER. IF THE COLOR OF LIME BE GRAYISH, PINKISH, OR YELLOWISH IT IS A SIGN THAT THERE WERE IMPURITIES IN THE STONE. THE APPEARANCE OF UNDERBURNED LIME VARIES WITH THAT OF THE STONE WHILE OVERBURNED LIME IS GENERALLY YELLOW OR BLACK IN COLOR.

### SLAKING.

QUICK LIME UPON EXPOSURE TO THE AIR WILL FALL TO A POWDER OR BECOME AIR SLAKED; THIS SHOULD NOT BE CONFUSED WITH THE PULVERIZED LIME DESCRIBED ABOVE. ALSO QUICK LIME WILL FALL TO A POWDER WHEN A DEFINITE QUANTITY OF WATER IS ADDED, A PROCESS KNOWN AS SLAKING; CONSIDERABLE HEAT WILL BE EVOLVED AND THE LIME WILL EXPAND NOTABLY IN BULK. THE QUANTITY OF WATER NECESSARY TO SLAKE WILL DEPEND UPON THE PURITY OF THE LIME; USUALLY 32% BY WEIGHT OF THE QUICK LIME IS REQUIRED FOR PURE LIME. THE MORE IMPURITIES PRESENT THE LESS WATER IS REQUIRED AND THE SMALLER THE INCREASE IN VOLUME. AFTER THE LIME HAS BEEN SLAKED IT IS KNOWN AS HYDRATED LIME AND IS A POWDER.

### SLAKING FOR BUILDING PURPOSES.

DIFFERENT KINDS OF LIME VARY CONSIDERABLY IN THE WAY IN WHICH THEY BEHAVE WITH WATER. TO FIND OUT THE METHOD BEST SUITED TO SLAKING A LIME IT IS BEST TO MAKE THE FOLLOWING TEST. IN A BUCKET PUT 2 OR 3 LUMPS OF LIME ABOUT THE SIZE OF THE FIST, OR IN THE CASE OF GRANULATED LIME, AN EQUIVALENT AMOUNT. ADD ENOUGH WATER TO JUST BARELY COVER THE LIME AND NOTE HOW LONG IT TAKES FOR THE SLAKING TO BEGIN. SLAKING HAS BEGUN WHEN PIECES SPLIT OFF FROM THE LUMPS OR WHEN THE LUMPS CRUMBLE. IF SLAKING BEGINS IN LESS THAN 5 MINUTES THE LIME IS QUICK SLAKING; FROM 5 TO 30 MINUTES, MEDIUM SLAKING; OVER 30 MINUTES, SLOW SLAKING.

### DIRECTIONS FOR SLAKING FOR BUILDING PURPOSES.

FOR QUICK-SLAKING LIME, ALWAYS ADD THE LIME TO THE WATER, NOT THE WATER TO THE LIME. HAVE ENOUGH WATER AT FIRST TO COVER ALL THE LIME COMPLETELY. HAVE A PLentiful SUPPLY OF WATER AVAILABLE FOR IMMEDIATE USE -







A HOSE THROWING A GOOD STREAM, IF POSSIBLE. WATCH THE LIME CONSTANTLY. AT THE SLIGHTEST APPEARANCE OF ESCAPING STEAM, HOE THOROUGHLY AND QUICKLY, AND ADD ENOUGH WATER TO STOP IT. DO NOT BE AFRAID OF USING TOO MUCH WATER WITH THIS KIND OF LIME.

FOR MEDIUM-SLAKING LIME, ADD THE WATER TO THE LIME. ADD ENOUGH WATER SO THAT THE LIME IS ABOUT HALF SUBMERGED. HOE OCCASIONALLY IF STEAM STARTS TO ESCAPE. ADD A LITTLE WATER NOW AND THEN IF NECESSARY TO PREVENT THE PUTTY FROM BECOMING DRY AND CRUMBLY. BE CAREFUL NOT TO ADD ANY MORE WATER THAN REQUIRED, AND NOT TOO MUCH AT A TIME.

FOR SLOW-SLAKING LIME, ADD ENOUGH WATER TO THE LIME TO MOISTEN IT THOROUGHLY. LET IT STAND UNTIL THE REACTION HAS STARTED. CAUTIONSLY ADD MORE WATER, A LITTLE AT A TIME, TAKING CARE THAT THE MASS IS NOT COOLED BY FRESH WATER. DO NOT HOE UNTIL THE SLAKING IS PRACTICALLY COMPLETE. IF THE WEATHER IS VERY COLD, IT IS PREFERABLY TO USE HOT WATER, BUT IF THIS IS NOT AVAILABLE, THE MORTAR BOX MAY BE COVERED IN SOME WAY TO KEEP THE HEAT IN.

LIME IS SHIPPED IN BARRELS OR IN BULK. IN DRY CLIMATES IT WILL KEEP FOR A LONG TIME IN BULK BUT IN DAMP CLIMATES IT SOON SLAKES UNLESS STORED IN BARRELS OR OTHER CONTAINERS. WHEN LIME IS STORED THE TOP AIR-SLAKES AND THIS POWDER FORMS A PROTECTION BY EXCLUDING THE AIR. IT SHOULD BE STORED IN A DRY PLACE TO PREVENT FIRE. LIME WEIGHS FROM 20-80 POUNDS PER BUSHEL,  $\frac{1}{2}$  BUSHELS ARE ESTIMATED TO A BARREL.

#### HYDRATED LIME.

LIME IS HYDRATED COMMERCIALY AND SOLD IN PAPER BAGS OF 40 LBS AND CLOTH SACKS OF 100 LBS.

FOLLOWING ARE REFERENCES TO PUBLISHED MATTER RELATING TO HYDRATED LIME:

THE MANUFACTURE AND PROPERTIES OF HYDRATED LIME, BY S. T. BRINGHAM, ENGINEERING NEWS, AUGUST 27, 1903.

LIME EXPERIMENTS, BY S. V. PEPPEL, ROCK PRODUCTS, APRIL-MAY 1904.

STRENGTH TESTS OF MIXTURES OF PORTLAND CEMENT AND HYDRATED LIME, BY, C. WARNER, ENGINEERING NEWS, DECEMBER 17, 1903.

STANDARDS ADOPTED BY MANUFACTURERS OF HYDRATED LIME, BY C. WARNER ENGINEERING NEWS, SEPTEMBER 8, 1904.

GENERAL INFORMATION ON THE USE OF LIME CAN BE HAD FROM THE NATIONAL LIME ASSOCIATION, 918 G STREET, N. W., WASHINGTON, D. C.

THE CHARACTER AND LOCATION OF LIMESTONES ARE REPORTED IN VARIOUS PUBLICATIONS OF THE U. S. GEOLOGICAL SURVEY, WHILE MANY OF THE STATE GEOLOGICAL SURVEYS HAVE REPORTS ON LIMESTONES FOUND IN THEIR STATES.

SOME OF THE STATE AGRICULTURAL COLLEGES HAVE ISSUED BULLETINS ON USE OF LIME IN AGRICULTURE.







THE FOLLOWING BULLETINS MAY BE PURCHASED FROM THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C. FOR THE PRICES QUOTED, STAMPS NOT ACCEPTED IN PAYMENT.

FARMERS' BULLETIN 921, "THE PRINCIPLES OF THE LIMING OF SOILS."

PRICE 5¢.

YEARBOOK SEPARATE 814, "HOME PRODUCTION OF LIME BY THE FARMER"

PRICE 5¢.

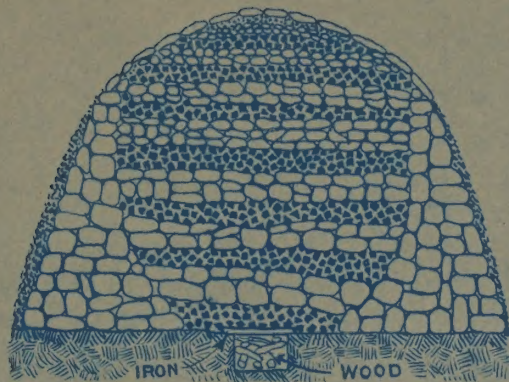




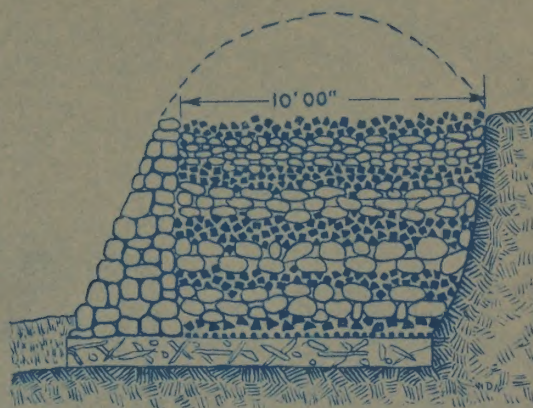


# DETAILS OF FARM LIME KILN

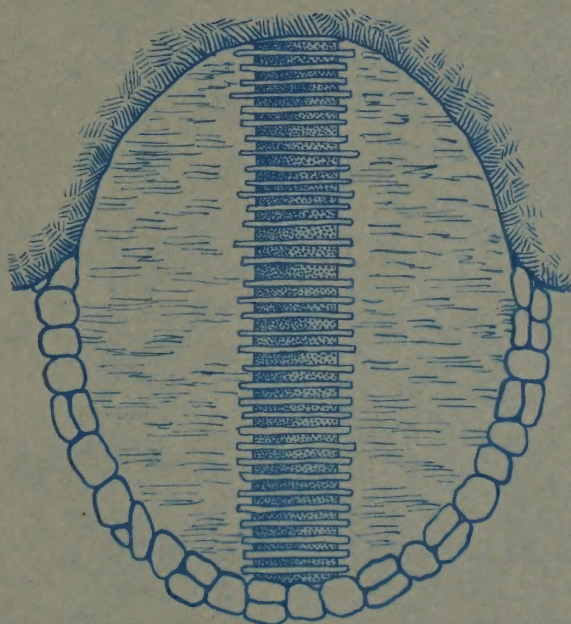
For about 250 to 300 bushels



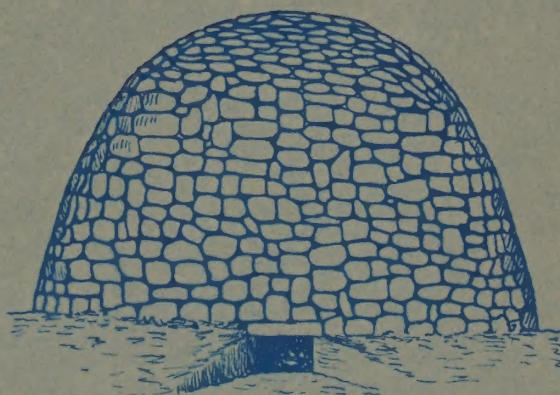
**CROSS SECTION**  
Showing layers of rock and coal



**LONGITUDINAL SECTION**  
Showing side hill used as back wall



**GROUND PLAN**  
Showing trench and grate



**COMPLETED KILN**  
Walled in and plastered with mud

|                                                          |          |                     |            |
|----------------------------------------------------------|----------|---------------------|------------|
| U.S. DEPARTMENT OF AGRICULTURE<br>BUREAU OF PUBLIC ROADS |          |                     |            |
| Div. of Agricultural Engineering                         |          |                     |            |
|                                                          |          | SHEET 1 OF 1 SHEETS |            |
|                                                          | W. D. N. | SUBJECT NO.         | SERIAL NO. |
|                                                          |          | 626-C1              | 1826       |

To accompany Information Series No. 49

Date... Apr. 19, 1924 ..... File... 30 .....







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

INFORMATION SERIES No. 50.

APRIL 1924.

PISE-DE-TERRE

PISE-DE-TERRE OR "COB" WAS A WELL KNOWN AND COMMONLY USED TYPE OF CONSTRUCTION IN EUROPE UNTIL ABOUT 100 YEARS AGO WHEN IT FELL INTO DISUSE BECAUSE OF ITS LIMITATIONS AND THE CHEAPNESS OF OTHER MATERIALS. THE PRESENT DEMAND FOR A CHEAP BUILDING MATERIAL HAS AWAKENED AN INTEREST IN THIS OLD FORM OF MASONRY AND, IN ENGLAND, THE GOVERNMENT HAS ERECTED SEVERAL HOUSES TO TEST THE PRACTICABILITY OF PISE IN MODERN CONSTRUCTION.

EARLY SETTLERS IN THE UNITED STATES USED EARTH IN THE CONSTRUCTION OF THEIR BUILDINGS; THE MISSION BUILDINGS OF CALIFORNIA AND TEXAS WERE BUILT OF ADOBE MOLDED INTO LARGE SIZE BRICKS WHICH WERE AIR-DRIED; THE SETTLERS IN THE WEST BUILT HOUSES OF SOD AND GOOD EXAMPLES OF THIS TYPE CAN BE FOUND IN NEBRASKA. A WELL PRESERVED HOUSE BUILT OF PISE ABOUT A HUNDRED YEARS AGO IS STILL STANDING IN WASHINGTON, D. C., AND WITHIN THE PAST YEAR A HOUSE HAS BEEN ERECTED, NEAR WASHINGTON, THE WALLS OF WHICH ARE OF PISE.

THE FOLLOWING DESCRIPTION OF THIS TYPE OF CONSTRUCTION IS ABSTRACTED FROM TWO ARTICLES; ONE PUBLISHED IN THE LONDON, "SURVEYOR", BY MR. CLOUGH WILLIAMS-ELLIS AND THE OTHER FROM A REPORT MADE BY THE BRITISH MINISTRY OF AGRICULTURE AND FISHERIES ON TEST HOUSES BUILT AT AMESBURY.

PISE-DE-TERRE IS MERELY EARTH TO WHICH NOTHING WHATEVER IS ADDED. THE EARTH IS DUG AND THROWN BETWEEN WOODEN FORMS AND RAMMED UNTIL IT IS PERFECTLY HARD AND COMPACT.

ALL EARTHS ARE NOT SUITABLE FOR PISE CONSTRUCTION AND PRELIMINARY TESTS SHOULD BE MADE TO DETERMINE THE SUITABILITY OF A SOIL BEFORE USE. THE ESSENTIAL QUALITIES OF A SOIL FOR PISE WORK ARE A FIRM COHERENCE OF THE PARTICLES WHEN RAMMED AND DRIED COMBINED WITH AN ABSENCE OF EXCESSIVE SHRINKAGE IN THE PROCESS OF DRYING. A PURE CLAY WOULD SATISFY THE FORMER CONDITION AND A PURE SAND OR GRAVEL THE LATTER YET NEITHER BY ITSELF COULD POSSIBLY BE USED FOR PISE WORK. ORDINARY EARTH IS GENERALLY SUITABLE BUT SHOULD BE FREE FROM ORGANIC MATERIALS HENCE TOP OR VEGETABLE SOILS ARE GENERALLY UNSUITABLE.

ASIDE FROM THE PROPER KIND OF EARTH AN ALL-IMPORTANT POINT IS THE MOISTURE CONTENT. THIS FACTOR WILL DEPEND UPON THE CHARACTER OF THE EARTH AND VARIES FROM 7 TO 14% OF THE WEIGHT OF THE DRIED EARTH. THE TENDENCY OF THE INEXPERIENCED IS TO WORK WITH TOO DAMP A SOIL. AS LONG AS THE RAMMER WILL CONSOLIDATE WITHOUT PULVERIZING THE MATERIAL IT MAY BE WET ENOUGH. SHOULD IT "PUG" UNDER THE RAMMER IT IS CERTAINLY TOO WET.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 101

Plasticity

Plasticity is the property of a material which enables it to be deformed permanently without rupture. It is a property which is common to all materials, but it is more pronounced in some than in others. The degree of plasticity is determined by the nature of the material and by the conditions under which it is deformed. In the case of soils, plasticity is a property which is of great importance in the design of foundations and in the construction of earth retaining structures.

There are two types of plasticity, namely, elastic and inelastic. Elastic plasticity is that property of a material which enables it to be deformed and then to return to its original shape when the deforming force is removed. Inelastic plasticity is that property of a material which enables it to be deformed and then to remain in its deformed shape when the deforming force is removed. In the case of soils, elastic plasticity is a property which is of great importance in the design of foundations and in the construction of earth retaining structures.

The degree of plasticity of a soil is determined by the nature of the soil and by the conditions under which it is deformed. In the case of soils, plasticity is a property which is of great importance in the design of foundations and in the construction of earth retaining structures.

Plasticity is a property which is common to all materials, but it is more pronounced in some than in others. The degree of plasticity is determined by the nature of the material and by the conditions under which it is deformed.

All earths are not suitable for the construction of foundations. The degree of plasticity of a soil is determined by the nature of the soil and by the conditions under which it is deformed. In the case of soils, plasticity is a property which is of great importance in the design of foundations and in the construction of earth retaining structures.

Since from the above it is seen that the degree of plasticity of a soil is determined by the nature of the soil and by the conditions under which it is deformed, it is evident that the degree of plasticity of a soil is a property which is of great importance in the design of foundations and in the construction of earth retaining structures.



THE PERCENTAGE OF MOISTURE CAN BE DETERMINED BY MAKING AND IMMEDIATELY, WEIGHING A SAMPLE TEST BLOCK AND AGAIN WEIGHING IT WHEN QUITE DRY; THE DIFFERENCE IN WEIGHT DIVIDED BY THE WEIGHT OF THE MOIST SAMPLE IS THE PERCENTAGE OF MOISTURE. THE PERCENTAGE OF SHRINKAGE SHOULD IN NO CASE EXCEED  $2\frac{1}{2}$  TO 3% AND CAN GENERALLY BE KEPT UNDER 2%.

### FORMS.

THE FORMS SHOULD BE BUILT SOMEWHAT LIKE THE TYPE OF MOVABLE FORMS USED IN CONCRETE WORK ABOUT 10 FEET LONG AND 3 FEET HIGH. THEY MUST BE VERY RIGID, TO WITHSTAND THE SEVERE RAMMING WHICH IS NECESSARY AND IN ORDER TO PRODUCE A STRAIGHT WALL. A SUGGESTED FORM IS SHOWN IN THE ACCOMPANYING PRINT. PROVISION, AS SHOWN, MUST BE MADE AT THE ENDS FOR BONDING SUCCESSIVE SECTIONS OF THE WALL; ALSO STOPS MUST BE PROVIDED TO FORM WINDOW AND DOOR OPENINGS SINCE FRAMES PLACED AS THE WORK PROCEEDS ARE APT TO BE BENT OR KNOCKED OUT OF PLACE.

### RAMMERS.

GOOD TYPES OF RAMMERS ARE SHOWN IN THE ACCOMPANYING DRAWINGS.

### CONSTRUCTION.

THE FOUNDATIONS AND ALL EXTERIOR WALLS IN CONTACT WITH EARTH MUST BE OF CONCRETE OR OTHER MASONRY TO A LEVEL OF ONE FOOT ABOVE THE FINAL GRADE OF THE GROUND SURFACE. INTERIOR PARTITION WALLS MAY BE OF EARTH. A GOOD DAMP-PROOF COURSE ON TOP OF THE FOOTINGS IS ESSENTIAL AND MAY CONSIST OF A LAYER OF SLATE EMBEDDED IN MORTAR OR, SEVERAL THICKNESSES OF TARRIED FELT EMBEDDED IN TAR OR LAYERS OF OTHER IMPERVIOUS MATERIALS. THE EARTH MAY BE SAVED FROM THE FOUNDATION EXCAVATION OR TAKEN FROM WHERE IT IS CONVENIENT IN THE IMMEDIATE VICINITY AFTER FIRST REMOVING THE TOP SOIL. THE SMALL AMOUNT OF EARTH REQUIRED FOR THE WALLS OF EVEN A CONSIDERABLE SIZE HOUSE IS SURPRISING.

THE EARTH SHOULD BE SIFTED TO REMOVE ALL STONES ABOVE A WALNUT SIZE; ALL STICKS, LEAVES OR OTHER VEGETABLE MATTER MUST BE ELIMINATED AND THE EARTH PILED WHERE CONVENIENT TO KEEP IT FROM DRYING OUT OR ABSORBING TOO MUCH MOISTURE.

THE FOOTING OF THE FOUNDATION WALLS SHOULD BE BELOW FROST LINE AND WIDE ENOUGH TO SUPPORT AN 18 INCH WALL, THE THICKNESS RECOMMENDED FOR THE 1ST STORY OF PISE STRUCTURES. THE 2ND STORY WALL MAY BE 14 INCHES THICK. AFTER THE CONCRETE HAS BEEN PLACED THE DAMP-PROOF COURSE SHOULD BE LAID; IF OF SLATE A PROTECTING COURSE OF CONCRETE OR BRICK SHOULD BE LAID ABOVE IT TO PREVENT FRACTURING THE SLATE WHEN RAMMING.

ERECT THE FORMS PLUMB AND TRUE ON THE FOUNDATION. THROW IN A 4 INCH LAYER OF EARTH AND RAM UNTIL SO SOLID THAT IT RINGS; THE LAYER IS GENERALLY COMPRESSED TO ABOUT 2 INCHES; 4 MORE INCHES OF EARTH ARE ADDED AND RAMMED SOLID AND THIS PROCESS IS CONTINUED UNTIL THE FORM IS FILLED, IMMEDIATELY AFTER WHICH THE FORM CAN BE TAKEN DOWN AND ERECTED, FOR ANOTHER SECTION, THUS DIFFERING FROM CONCRETE WORK. THE SUCCESS OF THE WORK DEPENDS UPON THE THOROUGHNESS OF THE RAMMING ESPECIALLY AT THE CORNERS AND ALONG THE EDGES; THE RAMMING HOWEVER MUST NOT BE DONE IN UNISON.







WHERE THERE IS TO BE NO CELLAR 3 OR 4 INCH TILE PIPES SHOULD BE SET CROSSWISE IN THE FORMS, SO AS TO PROVIDE VENTILATION UNDER THE GROUND FLOOR, AND SHOULD BE FITTED WITH WIRE MESH STOPS TO EXCLUDE VERMIN. BOLTS SHOULD BE PROVIDED, AS IN OTHER MASONRY, FOR ANCHORING THE ROOF PLATES TO THE WALL.

THE USUAL METHOD OF FORMING LINTELS IS TO PLACE 2x4's SIDE BY SIDE THROUGH THE THICKNESS OF THE WALL. THE DETAILS OF THE LINTEL CONSTRUCTION AND THE JAMBS WILL DEPEND UPON THE TYPE OF WINDOW USED. THE LINTELS SHOULD BEAR ON THE WALL 9 INCHES AT EACH END. IT WOULD SEEM THAT A PRE-CAST CONCRETE LINTEL MIGHT BE USED TO ADVANTAGE.

SILLS MAY BE OF EITHER CONCRETE, 3 INCHES THICK THROUGH THE THICKNESS OF THE WALL, OR BRICK WITH PROJECTING WOOD SILLS.

WOOD PLUGS OR BUCKS 2"x4"x9" SHOULD BE LEFT IN THE WALL AT INTERVALS AROUND ALL OPENINGS FOR SECURING THE FRAMES. PLUGS SHOULD BE SET IN THE FORMS SO AS TO BE BUILT IN THE WALL WHERE EVER WOOD TRIM SUCH AS MOP BOARD, WAINSCOTING, PICTURE MOLDING, ETC., IS TO BE SECURED. TWO INCH BLOCKS ARE SET IN THE FORM TO FORM POCKETS TO RECEIVE THE ENDS OF FLOOR JOISTS WHICH SHOULD BEAR 9 INCHES IN THE WALL. BRICK WORK SHOULD BE BONDED TO PISE WALLS BY DRIVING NAILS INTO THE LATTER EVERY FEW COURSES AT JOINT LEVELS.

IT IS ESSENTIAL THAT THE DESIGN SHOULD BE SUITED TO THE CONSTRUCTION, SQUARE OR OBLONG PLANS WITHOUT BREAKS BEING MOST SUITABLE. GABLES AND HIGH WALLS SHOULD BE AVOIDED AND SECOND STORY ROOMS FORMED AS MUCH AS POSSIBLE IN THE ROOF. EAVES SHOULD BE GIVEN A GOOD PROJECTION. CORNERS SHOULD BE ROUNDED; THIS CAN BE ACCOMPLISHED BY PROVIDING SPECIAL CORNER MOLDS OR BY SCRAPING AWAY THE EARTH AFTER REMOVAL OF THE FORM.

INTERNAL WALLS HAVE BEEN PLASTERED WITH SEEMINGLY VERY SATISFACTORY RESULTS, BUT WHERE THE PISE HAS BEEN LEFT WITH A GOOD AND FAIRLY UNBROKEN SURFACE, IT IS CONSIDERED SUFFICIENT TO FINISH WITH A BRUSH COAT OF WHITE-WASH OR CEMENT GROUT IN CASES WHERE EXCEPTIONAL WEAR IS NOT EXPECTED. BEFORE PLASTERING THE SMOOTH SURFACE OF THE WALLS SHOULD BE ROUGHENED TO GIVE A GOOD KEY TO THE PLASTER. ALL LOOSE EARTH SHOULD BE REMOVED WITH A STIFF BRUSH AND THE WALL SURFACE EVENLY WETTED. INTERIOR WALLS BEARING LITTLE OR NO WEIGHT CAN BE MADE 9 TO 12 INCHES THICK.

#### EXTERNAL COATINGS.

IT IS ADVISABLE TO PROTECT THE OUTSIDE OF THE WALLS WITH SOME WATER-PROOF COAT. THEY MAY BE SPRAYED WITH HOT TAR, COLOR WASHED OR PLASTERED WITH CEMENT STUCCO.

PISE HOUSES ARE VERY UNIFORM IN TEMPERATURE AND DRY ON ACCOUNT OF THE EXCELLENT INSULATING PROPERTIES OF EARTH.







IF PROPERLY PROTECTED BY SCREENS OR TARPAULINS BUILDING IN PISE CAN BE CARRIED ON IN WINTER BUT AT SOMEWHAT GREATER EXPENSE. HOWEVER WINTER CONSTRUCTION IS NOT ADVISABLE.

THE COST OF PISE WALLS IN THE TEST HOUSES AT AMESBURY WAS ABOUT  $\frac{3}{5}$  THAT OF BRICK WALLS AND IT IS BELIEVED THAT THE COST IS LESS THAN THIS WHEN HANDLED BY BUILDERS EXPERIENCED IN THE USE OF PISE. FIRE PLACES, FLUES AND CHIMNEYS SHOULD BE BUILT OF BRICK OR OTHER MASONRY.

WHERE THE SITE IS WELL DRAINED AND THE GROUND FLOOR LEVEL IS BUT A LITTLE ABOVE THE LEVEL OF THE OUTSIDE GRADE, WOOD FLOOR JOISTS CAN BE ELIMINATED. UNDER SUCH CONDITIONS A CONCRETE FLOOR CAN BE PLACED ON A FILL AND A WOOD FLOOR SECURED TO SLEEPERS IN THE CONCRETE.

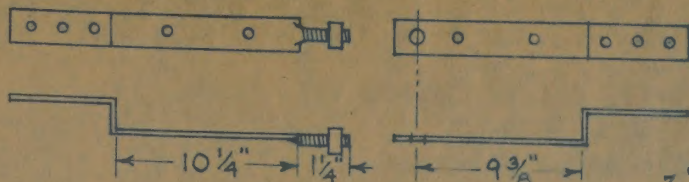


If properly protected by screens or tarpaulins during in place  
can be carried on in winter but at somewhat greater expense. However  
winter construction is not advisable.

The cost of pipe walls in the test house at Melbourne was about  
3/8 that of brick walls and it is believed that the cost is less than  
this when rendered on buildings experienced in the use of pipe. The  
pipes, flues and chimneys should be built of brick or other masonry.

Where the site is well drained and the ground floor level is not  
fitted above the level of the outside ground, where floor joists can be  
eliminated. When such conditions a concrete floor can be placed on a  
fill and a wood floor secured to members in the concrete.

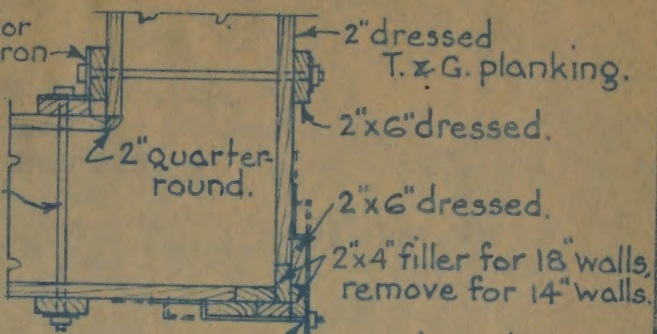




METAL CORNER IRONS  
1/4" x 2" strap iron.

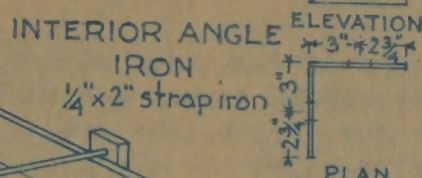
Interior  
angle iron

1/8" tie rod



PLAN OF  
CORNER

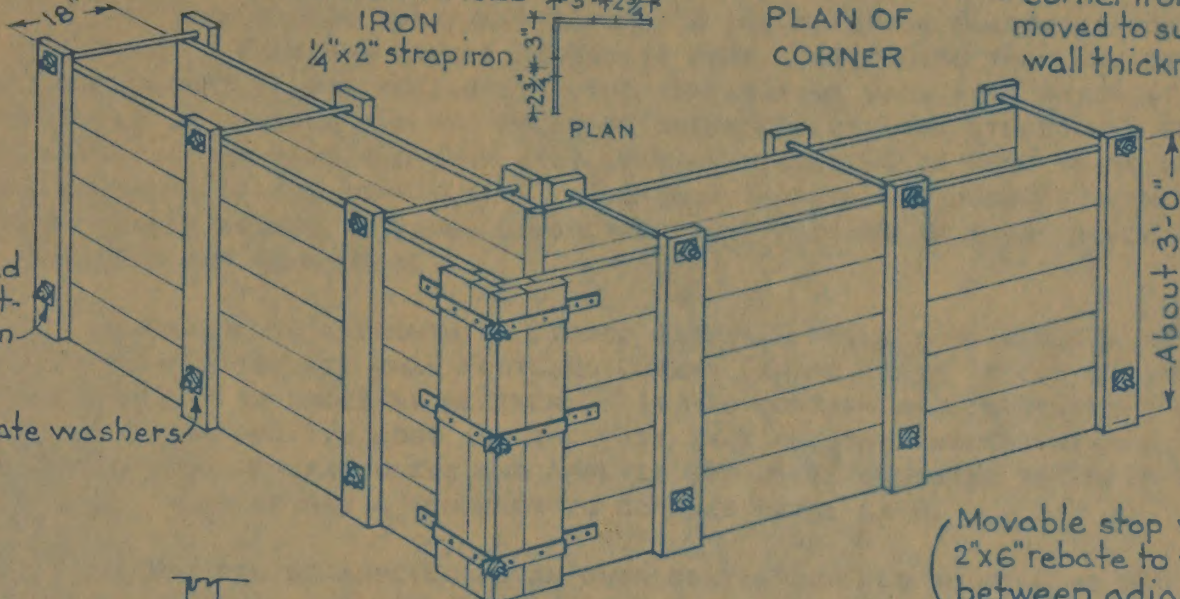
Corner irons to be  
moved to suit various  
wall thicknesses.



INTERIOR ANGLE  
IRON  
1/4" x 2" strap iron

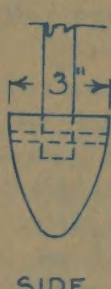
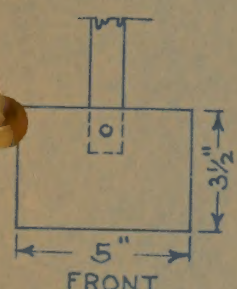
Rod located  
6" above bot-  
tom of form

1/8" x 3" x 3" plate washers

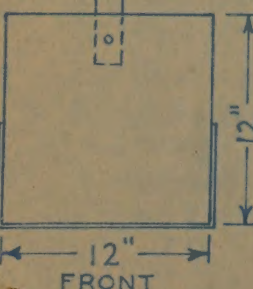
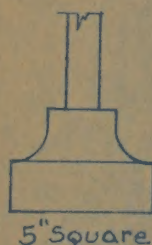


FORM FOR CORNERS

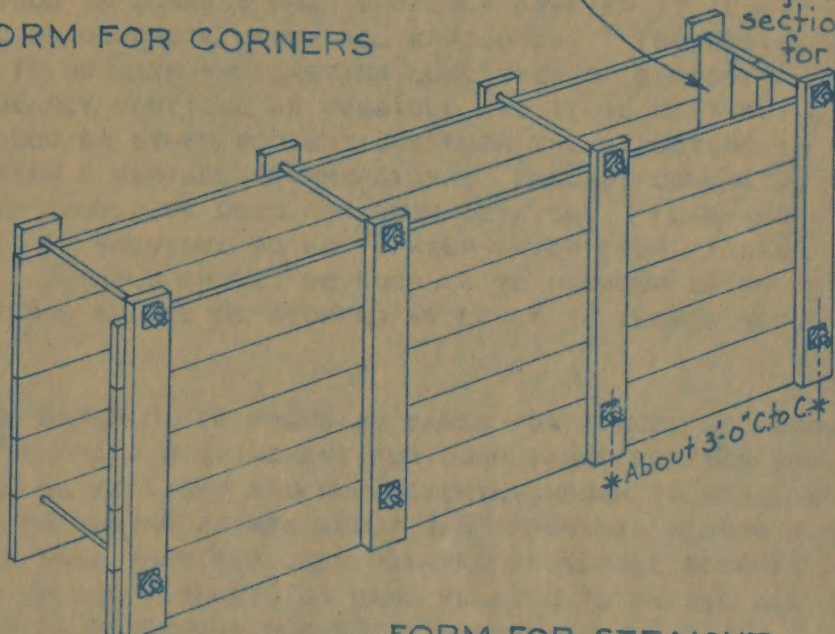
Movable stop with beveled  
2"x6" rebate to form bond  
between adjacent wall  
sections. Forms  
for openings  
similar.



CAST IRON  
RAMMERS  
weighing about  
7 pounds.



WOOD RAMMER

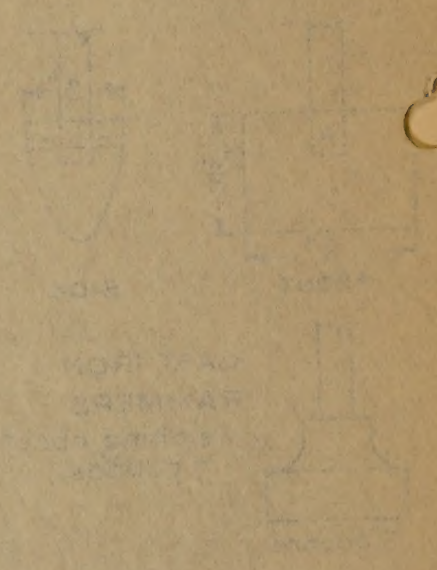
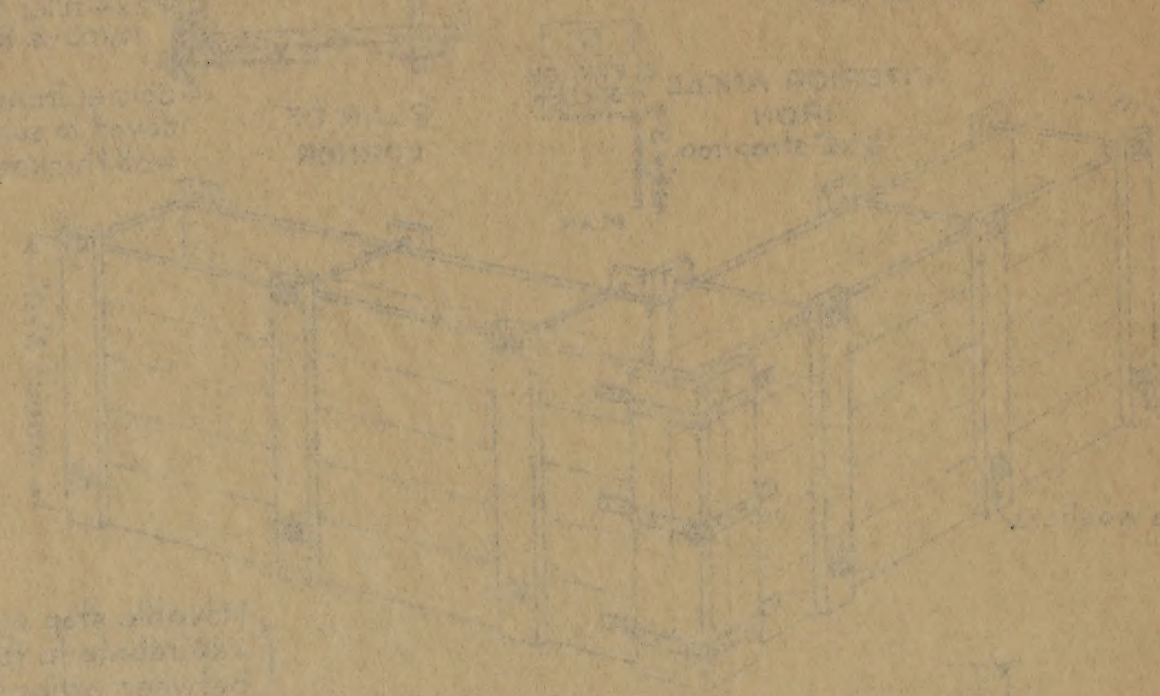


FORM FOR STRAIGHT  
WALLS  
Using planks 10 to 12 feet long.

|                                                          |         |                                                             |            |
|----------------------------------------------------------|---------|-------------------------------------------------------------|------------|
| U.S. DEPARTMENT OF AGRICULTURE<br>BUREAU OF PUBLIC ROADS |         |                                                             |            |
| DIVISION OF<br>AGRICULTURAL ENGINEERING                  |         |                                                             |            |
| PISÉ FORMS                                               |         |                                                             |            |
| Scale                                                    | CHECKED | SHEET <input type="radio"/> OF <input type="radio"/> SHEETS |            |
| Drawn by N.B.                                            |         |                                                             |            |
| Traced by N.B.                                           |         |                                                             |            |
| APPROVED                                                 |         | SUBJECT                                                     | SERIAL NO. |
|                                                          |         | 607-D-4                                                     | 1854       |

To accompany Information Series # 50







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

INFORMATION SERIES No. 51.

MAY, 1924.

STUCCO

THE TERM STUCCO GENERALLY REFERS TO THE EXTERIOR PLASTERED COAT OF A STRUCTURE. PORTLAND CEMENT STUCCO IS MORE WIDELY USED THAN ANY OTHER KIND ON ACCOUNT OF ITS RELIABILITY, THE COMPARATIVE EASE WITH WHICH IT IS HANDLED BY AN AMATEUR AND ITS RELATIVE CHEAPNESS. LIME STUCCO HAS BEEN MUCH USED IN THE PAST AND MANY EXCELLENT EXAMPLES 100 OR MORE YEARS OLD BEAR EVIDENCE OF ITS DURABILITY. THE REQUIREMENTS FOR SUCCESS WITH LIME STUCCO CANNOT BE MET IN GENERAL CONSTRUCTION PRACTICE OF TODAY HENCE THIS MATERIAL IS NOT MUCH USED.

MAGNESITE IS A PROMISING STUCCO MATERIAL POSSESSING GREATER PLASTICITY AND FLEXIBILITY THAN PORTLAND CEMENT STUCCO, ALSO IT CAN BE APPLIED WITHOUT INJURY IN FREEZING WEATHER. IT HAS CERTAIN DISADVANTAGES THE CHIEF OF WHICH ARE ITS COST AND THE FACT THAT ALL THE INGREDIENTS MUST BE PURCHASED FROM MANUFACTURERS AND APPLIED STRICTLY ACCORDING TO THEIR DIRECTIONS; ALSO IT HAS A TENDENCY TO CORRODE METAL LATH.

STUCCO CAN BE APPLIED AS AN OVER COATING ON OLD AS WELL AS NEW STRUCTURES. WHILE STUCCO IS DURABLE WHEN PROPERLY APPLIED IT IS NOT AS DURABLE AS BRICK, STONE OR CONCRETE UNDER ALL EXPOSURES. THE DESIGN OF THE STRUCTURE HAS MUCH TO DO WITH THE LASTING QUALITIES OF STUCCO. ALL SURFACES SHOULD BE AS NEARLY VERTICAL AS POSSIBLE AND IT IS BEST NOT TO STUCCO OVER COPINGS, SILLS OR OTHER PROJECTIONS WHEN THE STRUCTURE IS ERECTED IN LOCALITIES WITH A VARIABLE TEMPERATURE; PRECAST CONCRETE, STONE OR OTHER MATERIALS SHOULD BE USED FOR SUCH DETAILS. FLASHING AT CORNERS AND EAVES SHOULD BE PROVIDED SO AS TO KEEP WATER FROM FINDING ITS WAY BEHIND THE STUCCO. DETAILS SHOULD BE SUCH AS TO PREVENT DRIPS WHICH STAIN THE SURFACE. STUCCO SHOULD BE STOPPED AT LEAST 12 INCHES ABOVE THE GROUND.

MASONRY WALLS ARE SUPERIOR TO FRAME AS BASES FOR STUCCO ON ACCOUNT OF THEIR STABILITY. THE CHIEF REQUIREMENT FOR SUCH BASES BESIDES RIGIDITY ARE THAT THEY SHOULD BE STRAIGHT AND SUFFICIENTLY ROUGH TO PROVIDE A GOOD KEY; RAKING OUT THE MORTAR JOINTS ABOUT  $\frac{3}{8}$ " PROVIDES A GOOD BOND, A BRICK OR OTHER MASONRY WALL THAT HAS BEEN PAINTED SHOULD BE COVERED WITH METAL LATH, HACKED WITH AN OLD HATCHET, OR SAND BLASTED TO REMOVE ALL PAINT, OIL OR OTHER MATERIAL WHICH MAY PREVENT A GOOD BOND.

FRAME STRUCTURES ESPECIALLY THOSE TO BE COVERED WITH STUCCO REQUIRE RIGID BRACING TO PREVENT RACKING AND A GOOD FOUNDATION TO PREVENT SETTLING. DIAGONAL BRACES OF 1" X 6" BOARDS 6 OR 8 FT. LONG LET INTO THE STUDS ON THEIR INNER SIDES AT THE UPPER AND LOWER CORNERS OF EACH WALL AND BRIDGING BETWEEN THE STUDS AT LEAST ONCE IN EVERY STORY HEIGHT SERVE TO BRACE THE WALLS OF ORDINARY FRAME STRUCTURES. SUCH BRACING IS NOT SO ESSENTIAL IF



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF HIGHWAY CONSTRUCTION

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STUDIOS

The term studio generally refers to the exterior plastered coat of a structure. Portland cement stucco is more widely used than any other kind on account of its relative economy, the comparatively easy manner in which it is applied by an airless gun, and its relative durability. Fine stucco has been used in the past with excellent results, but it is more expensive and a evidence of its durability. The requirements for success with this stucco cannot be met in general construction practice or today hence this material is not much used.

Stucco is a protective material possessing certain plasticity and flexibility that Portland cement stucco, when it can be applied in that manner in practice is there. It is certain disadvantages the chief of which are its cost and the fact that all the ingredients must be purchased from manufacturers and applied strictly according to their directions. Also it has a tendency to corrode metal lath.

Stucco can be a plaster or an over coating on old as well as new structure. While stucco is durable when properly applied it is not as durable as brick, stone or concrete when all exposures. The reason for this is that stucco has to be applied in the last quality of stucco. All exposures should be as little as possible and it is best not to expose over corners, eaves or other projections when the structure is erected in localities with a variable temperature; frost concrete, stone or other materials should be used for such details. Flashing at corners and eaves should be provided so as to keep water from running down the side of the stucco. Details should be such as to prevent drain water from the surface. Stucco should be stopped at least 12 inches above the ground.

Masonry walls are superior to frame as bases for stucco on account of their stability. The chief requirement for such bases besides rigidity is that they should be straight and sufficiently rough to provide a good key. It is not the mortar joints about 3/8" provides a good bond, a brick or other masonry wall that has been painted should be covered with wet lath, backed with an old material, or sand blasted to remove all paint, oil or other material which may prevent a good bond.

Frame structures especially those to be covered with stucco require rigid bracing to prevent warping and a good foundation to prevent settling. Diagonal braces of 1" x 2" corner 6 on 5 ft. long lay into the studs on their inner sides at the upper and lower corners of each wall and bracing between the studs at least once in every story height serve to brace the walls or prevent them from twisting. Such bracing is not so essential in



THE WALLS ARE TO BE SHEATHED BUT IS ON THE SIDE OF CAUTION. IF STUCCO IS TO BE APPLIED OVER SHEATHING THE STUDS USUALLY ARE PLACED 16" ON CENTERS BUT IF THE SHEATHING IS OMITTED A 12" SPACING IS PREFERABLE UNLESS A RIBBED OR STIFFENED LATH IS USED. STUDS SHOULD BE RUN FROM SILL TO EAVES, WITHOUT INTERVENING HORIZONTAL MEMBERS, BECAUSE OF THE GREATER STIFFNESS OBTAINED IN THIS WAY AND THE MINIMIZING OF SHRINKAGE.

#### WOOD FRAME BACK PLASTERED.

IN THIS TYPE OF CONSTRUCTION THE LATH PREFERABLY OF THE SELF FURRING TYPE, IS NAILED DIRECTLY TO THE OUTSIDE FACE OF THE STUDS, THE SHEATHING BEING OMITTED, AND AFTER TWO COATS OF THE STUCCO HAVE BEEN APPLIED TO THE EXTERIOR THE WALL IS BACK PLASTERED ON THE INSIDE SO AS TO EMBED THE LATH COMPLETELY AND FORM A HEAVIER WALL. THIS BACK PLASTER COAT USUALLY FINISHES 1/4 INCH OR MORE BACK OF THE FACES OF THE STUDS AND HELPS STIFFEN THE WALL. HORIZONTAL BRIDGING OF 2" X 3" MATERIAL SHOULD BE NAILED MIDWAY OF EACH STORY HEIGHT BETWEEN THE STUDS, 1" BACK FROM THE OUTSIDE FACE OF THE STUDS. ALL PARTITIONS, FRAMING AND OTHER HEAVY CONSTRUCTION SHOULD BE IN PLACE BEFORE THE STUCCO IS APPLIED SO AS TO AVOID SUBJECTING IT TO VIBRATIONS WHICH MAY CAUSE MORE OR LESS SERIOUS CRACKS. INSULATION IS PROVIDED BY NAILING FELT OR OTHER INSULATING MATERIAL BETWEEN THE STUDS IN SUCH A MANNER AS TO FORM A DOUBLE AIR SPACE BETWEEN THE INSIDE AND OUTSIDE PLASTER.

#### WOOD FRAME SHEATHED.

WHEN SHEATHING IS USED IT SHOULD BE LAID HORIZONTALLY INSTEAD OF DIAGONALLY AS IS COMMONLY PRACTICED. THE BOARDS SHOULD NOT BE OVER 8" WIDE AND SHOULD BE SECURELY NAILED AT EACH STUD. OVER THE SHEATHING SHOULD BE LAID A GOOD GRADE OF WATERPROOF PAPER EACH COURSE LAPPING 2 INCHES OVER THE UPPER EDGE OF THE COURSE BELOW. NEXT THE FURRING IS APPLIED ALONG THE LINE OF THE STUDS; HOWEVER SELF-FURRING LATH IS MORE ECONOMICAL THUS ELIMINATING SEPARATE FURRING STRIPS. THE LATH SHOULD BE APPLIED SO AS TO FORM AS NEARLY AS POSSIBLE A UNIFORM FABRIC OVER THE STRUCTURE. PARTICULAR ATTENTION SHOULD BE GIVEN TO THOROUGH TYING AND LACING THE JOINTS WITH GALVANIZED WIRE AND THE STAPLING SHOULD BE NOT MORE THAN 6" TO 8" APART OVER THE FURRING. METAL LATH SHOULD BE GALVANIZED OR PAINTED AND BE NOT THINNER THAN 24 GAUGE AND WEIGH NOT LESS THAN 3 1/4 LBS. PER SQ. YD. WOVEN WIRE ALSO SHOULD BE PAINTED OR GALVANIZED, AND BE OF AT LEAST 19 GAUGE WIRE, 2 1/2 MESHES TO THE INCH WITH STIFFENERS 8" ON CENTERS. 6" STRIPS OF METAL LATH SHOULD BE BENT AROUND ALL CORNERS AND STAPLED OVER THE LATH ON THE SIDES. IN APPLYING THE STUCCO THE FIRST COAT SHOULD BE PUSHED THROUGH THE LATH AND AGAINST THE WATERPROOF PAPER SO AS TO COMPLETELY EMBED THE LATH ON BOTH SIDES.

#### WOOD LATH ETC.,

WOOD LATH MAY BE USED IN LIEU OF METAL LATH. THE WALL SHOULD BE SHEATHED AS BEFORE DESCRIBED AND 2" X 7/8" FURRING NAILED 12" ON CENTERS VERTICALLY OVER THE SHEATHING PAPER. THE LATH SHOULD BE LAID HORIZONTALLY WITH 1/2" OPENINGS BETWEEN THEM AND JOINTS BROKEN EVERY 12TH COURSE. FOUR



THE WALLS ARE TO BE SHOWN OUT IN THE LINE OF CAUTION. IT SHOULD  
BE TO BE APPLIED OVER THE STUDY MATERIAL AND PLACED 12" ON  
CENTERS BUT IN THE CASE OF THE STUDY MATERIAL IT SHOULD BE PLACED 12"  
LESS A RIBBON OF STUDY MATERIAL IS USED. STUDY SHOULD BE RUN FROM THE  
TO CAUSE, WITHOUT INTERRUPTING HORIZONTAL MOVEMENT, BECAUSE OF THE GREAT  
DIFFERENCE OBTAINED IN THIS WAY AND THE MINIMIZING OF SHOCKING.

LESSON FROM THE WALL

IN THIS TYPE OF CONSTRUCTION THE LATH IS PLACED ON THE WALL  
FURNISHING THE LATH DIRECTLY TO THE STUDY MATERIAL. THE  
LATH IS PLACED ON THE WALL, AND AFTER TWO COATS OF THE STUDY HAVE BEEN  
APPLIED TO THE EXTERIOR THE WALL IS JACK PLASTERED ON THE INSIDE AS  
TO COVER THE LATH COMPLETELY AND FORM A HEAVY WALL. THE JACK PLASTER  
IS PLACED ON THE WALL 1/2" THICK OR MORE BACK OF THE LATH ON THE STUDY AND  
HELPS STRENGTHEN THE WALL. HORIZONTAL LATHING OF 1/2" X 3" STUDY SHOULD  
BE PLACED AROUND OF EACH STUDY MATERIAL BETWEEN THE STUDY, 1" FROM THE  
OUTSIDE FACE OF THE STUDY. ALL PARTITIONS, FRAMING AND OTHER HEAVY  
CONSTRUCTION SHOULD BE IN PLACE BEFORE THE STUDY IS APPLIED SO AS TO  
AVOID SUGGESTING IT TO VIBRATIONS WHICH MAY CAUSE MORE OR LESS SERIOUS  
SHOCKING. INSULATION IS PROVIDED BY BUILDING UP ON OTHER INSULATION  
TERIAL BETWEEN THE STUDY IN SUCH A MANNER AS TO FORM A DOUBLE AIR SPACE  
BETWEEN THE INSIDE AND OUTSIDE PLASTER.

LESSON FROM THE STUDY

WHEN SOMETHING IS USED IT SHOULD BE LATH PLACED ON THE STUDY  
OR STUDY. IT IS COMMONLY PLACED. THE STUDY SHOULD NOT BE OVER 2"  
WIDE AND SHOULD BE PLACED AT 12" ON STUDY. OVER THE STUDY  
SHOULD BE LATH A GOOD GRADE OF WATERPROOF PAPER EACH COAT BEING 2"  
THICK OVER THE OTHER END OF THE STUDY. NEXT THE STUDY IS  
APPLIED ALONG THE LINE OF THE STUDY; HOWEVER, BETWEEN STUDY LATH IS MORE  
ECONOMICAL THAN ELIMINATING LATH-IT FURNISHES STRENGTH. THE LATH SHOULD  
BE APPLIED SO AS TO FORM A HEAVY AS POSSIBLE A HEAVY LATH OVER THE  
STUDY. PARTICULAR ATTENTION SHOULD BE GIVEN TO THICKENING THE LATH  
FACING THE STUDY WITH GALVANIZED WIRE AND THE STUDY SHOULD BE NOT  
MORE THAN 2" TO 3" AT THE STUDY. LATH LATH SHOULD BE PLACED  
NEARLY PLACED AND BE NOT THICKER THAN 2" LATH AND BE NOT LESS THAN  
2 1/2" FOR STUDY. WHEN WIRE ALSO SHOULD BE PLACED OR GALVANIZED,  
AND BE OF AT LEAST 12 GAUGE WIRE, 2 1/2" SPACED TO THE INCH WITH LATHING  
2" ON CENTERS. 2" LATH OF METAL LATH SHOULD BE PLACED AROUND ALL CORNERS  
AND STRENGTHEN THE LATH ON THE STUDY. IN APPLYING THE STUDY THE STUDY  
COAT SHOULD BE PLACED THROUGH THE LATH AND AGAINST THE WATERPROOF PAPER SO  
AS TO COMPLETELY COVER THE LATH ON BOTH SIDES.

LESSON FROM THE STUDY

WOOD LATHING IS USED IN CASE OF METAL LATH. THE WALL SHOULD BE  
SHOWN AS STUDY COVERED AND 2" X 3/4" FURNISHING LATHING 12" ON CENTERS  
VERTICALLY OVER THE STUDY MATERIAL. THE LATH SHOULD BE LATH HORIZONTAL  
WITH 1/2" SPACING BETWEEN THEM AND JOINTS BROKEN EVERY 12TH COAT. FOUR



PENNY GALVANIZED NAILS SHOULD BE USED. GALVANIZED METAL LATH STRIPS 6" WIDE SHOULD BE PLACED AROUND ALL OPENINGS AND BENT OVER CORNERS. IT IS IMPERATIVE THAT THE LATH BE THOROUGHLY WET AND TIME ALLOWED FOR THE WATER TO BE ABSORBED BEFORE APPLYING THE STUCCO.

THERE IS MUCH CONTROVERSY AS TO THE RELATIVE MERITS OF WOOD AND METAL LATH. IF PROPERLY USED WOOD LATH MAY GIVE GOOD SERVICE BUT IT MAKES POOR REINFORCEMENT. IF THOROUGHLY SWELLED BY SOAKING WITH WATER THE STUCCO SHOULD NOT FALL AWAY. METAL LATH MUST BE THOROUGHLY EMBEDDED TO PREVENT CORROSION.

THERE ARE MANY TYPES OF PLASTER BOARDS AND PREPARED SHEATHINGS ON THE MARKET BUT SPACE DOES NOT PERMIT A DISCUSSION OF THEIR MERITS. LOCAL USERS SHOULD BE CONSULTED AS TO THE SUCCESS ACCOMPANYING THEIR USE.

#### OVER COATING.

WHERE A STRUCTURE HAS BEEN WEATHERBOARDED AND THE FRAMING IS IN GOOD CONDITION IT CAN BE REMODELED BY OVER COATING. IF THE WEATHERBOARDING IS IN GOOD CONDITION IT SHOULD BE THOROUGHLY NAILED TO THE STUDS, COVERED WITH WATER PROOF PAPER AND THEN TREATED AS AN ORDINARY SHEATHED STRUCTURE, STUCCOING OVER METAL LATH APPLIED TO FURRING STRIPS. IF THE WEATHERBOARDING IS IN BAD CONDITION IT SHOULD BE REMOVED. SPECIAL PROVISION SHOULD BE MADE TO EXTEND THE FRAMES OF WINDOW AND DOOR OPENINGS TO MEET THE INCREASED THICKNESS OF THE WALL.

#### NUMBER OF COATS.

FIRST CLASS STUCCO SHOULD BE THREE COAT WORK. THE FIRST OR SCRATCH COAT SHOULD THOROUGHLY COVER AND BOND FIRMLY TO THE BASE AND BE AT LEAST 1/4" THICK. THIS COAT IS SCRATCHED OR SCORED WITH A SAW TOOTHED RADDLE TO PROVIDE A KEY FOR THE SECOND COAT. THE SECOND COAT IS USUALLY APPLIED THE DAY AFTER THE FIRST COAT AND ITS FUNCTION IS TO STRAIGHTEN THE WALL; IT IS GENERALLY 3/8" TO 1/2" THICK. WHEN PARTIALLY SET THE SECOND COAT IS GONE OVER WITH A WOOD FLOAT TO COMPACT IT PROPERLY AND IS THEN LIGHTLY SCORED. THE FINISH COAT IS NOT APPLIED FOR SEVERAL DAYS (THE LONGER THE BETTER) AFTER THE SECOND COAT SO THAT MOST OF THE SHRINKAGE IN THE UNDER COATS CAN TAKE PLACE. IT IS GENERALLY 1/4" THICK. METHODS OF FINISHING THE FINAL COAT ARE DESCRIBED FURTHER ON.

#### MIXTURE.

THE MORTAR FOR THE FIRST TWO COATS IS BEST MIXED IN THE PROPORTIONS OF 1 CU. FT. PORTLAND CEMENT, 3 CU. FT. OF SAND AND 10 POUNDS OF HYDRATED LIME PER SACK (CU. FT.) OF CEMENT. THIS MIXTURE IS SLIGHTLY LEANER THAN GENERALLY ADVOCATED BUT IS LESS LIABLE TO CRACK THAN RICHER MIXTURES. THE FINAL COAT MAY BE MIXED THE SAME AS THE PRECEDING THOUGH SOMETIMES 2 1/2 CU. FT. OF SAND IS USED IN PLACE OF 3 CU. FT., THE QUANTITY OF LIME REMAINING THE SAME. HAIR IS USED IN THE FIRST COAT ON WOOD LATH, AND MAY BE USED IN THE SCRATCH COAT ON METAL LATH WHICH IS TO BE BACK PLASTERED BUT IT IS NOT USED ON METAL LATH OVER SHEATHING (UNLESS FURRING DEEPER THAN 3/8" IS USED) NOR ON ANY TYPE OF MASONRY BACKING. ONLY SUFFICIENT MORTAR SHOULD BE MIXED AT ONE TIME AS CAN BE USED WITHIN 1 HOUR AS RETEMPERING DESTROYS THE BONDING STRENGTH OF THE CEMENT.



When the concrete is placed in the form, it is important that the concrete is placed in the form and not over the form. It is important that the concrete is placed in the form and not over the form. It is important that the concrete is placed in the form and not over the form.

There is much controversy as to the relative merits of wood and metal forms. It is generally held that wood forms give good results but it is important that the concrete is placed in the form and not over the form. It is important that the concrete is placed in the form and not over the form. It is important that the concrete is placed in the form and not over the form.

There are many types of master boards and various treatments on the market but each does not merit a discussion of their merits. Local agents should be consulted as to the success of each type of treatment.

Over-curing. Over-curing is a condition in which the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended.

Methods of curing. There are many methods of curing concrete. It is important that the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended.

Remarks. The remarks for the first two coats is best mixed in the proportions of 1 part cement, 2 parts sand and 3 parts water. It is important that the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended. It is a condition in which the concrete is cured for a longer period than is recommended.



## WATERPROOFING.

WATERPROOFING SHOULD NOT BE NECESSARY IN PROPERLY MIXED AND APPLIED PORTLAND CEMENT STUCCO. THE STUCCO WILL ABSORB WATER TO A CERTAIN EXTENT IN RAINY WEATHER, BUT THIS IS NOT INJURIOUS. CREOSOTING OR OTHER PAINTING OF EDGES OF STUDS IN BACKPLASTER WORK IS OF QUESTIONABLE VALUE.

## APPLYING THE STUCCO.

WETTING OF EACH COAT IS NECESSARY BEFORE APPLYING THE SUCCEEDING COAT TO PREVENT ABSORPTION OF WATER FROM THE FRESH COAT. IT IS ALSO DESIRABLE TO CURE THE SECOND COAT BY KEEPING IT DAMP FOR TWO OR THREE DAYS FOLLOWING ITS APPLICATION AND THE SAME TREATMENT SHOULD BE GIVEN THE FINAL COAT. FRESH COATS SHOULD BE PROTECTED FROM SUN, RAIN AND FROST. AS A GENERAL RULE EXTERIOR PLASTERING SHOULD NOT BE DONE UNDER EXTREME WEATHER CONDITIONS. THE STUCCOING SHOULD BE CARRIED ON IN ONE GENERAL DIRECTION WITHOUT ALLOWING THE STUCCO TO DRY OUT AT THE EDGE. IF IT IS IMPOSSIBLE TO WORK THE FULL WIDTH OF THE WALL AT ONE TIME, THE BREAK SHOULD BE AT SOME NATURAL DIVISION OF THE SURFACE SUCH AS A WINDOW OR DOOR. ALWAYS START AT THE TOP AND WORK DOWN.

## FINISH.

THE METHOD OF FINISHING THE FINAL COAT DEPENDS UPON THE FANCY OF THE WORKER. THE ROUGH FINISHES ARE LOW IN COST, REQUIRE LESS SKILL AND HAVE THE ADVANTAGE OF HIDING A VERY FINE SHRINKAGE CRACKS. THE SAND FINISH WHEN SKILLFULLY EXECUTED IS VERY ARTISTIC AND CAN BE VARIED IN COLOR BY USE OF PIGMENTS OR COLORED AGGREGATE BUT IT REQUIRES SKILL AND AN APPRECIATION OF ARTISTIC EFFECT. HOWEVER A PLAIN, SAND FINISH, SURFACE CAN BE PRODUCED AFTER A LITTLE PRACTICE. AFTER THE FIRST TWO COATS HAVE HAD SUFFICIENT TIME TO DRY THE SECOND COAT SHOULD BE DAMPENED AND THE THIRD APPLIED AND TREATED IN ONE OF THE FOLLOWING WAYS.

SMOOTH TROWELED - THE FINISHING COAT SHOULD BE TROWELED SMOOTH WITH A METAL TROWEL WITH AS LITTLE RUBBING AS POSSIBLE.

STIPPLED - THE FINISHING COAT SHOULD BE TROWELED SMOOTH WITH A METAL TROWEL WITH AS LITTLE RUBBING AS POSSIBLE, AND THEN LIGHTLY PATTED WITH A BRUSH OF BROOM STRAWS TO GIVE AN EVEN STIPPLED SURFACE.

SAND FLOATED - AFTER THE FINISHING COAT HAS BEEN BROUGHT TO A SMOOTH, EVEN SURFACE IT IS RUBBED WITH A WOOD FLOAT WITH A CIRCULAR MOTION A LITTLE SAND BEING ADDED TO SLIGHTLY ROUGHEN THE SURFACE. THIS FLOATING MUST BE DONE WHEN THE MORTAR HAS PARTLY SET.

SAND SPRAYED - AFTER THE FINISHING COAT HAS BEEN BROUGHT TO AN EVEN SURFACE, IT IS SPRAYED BY MEANS OF A WIDE, LONG FIBRE BRUSH - A WHISK BROOM DOES VERY WELL - DIPPED INTO A CREAMY MIXTURE OF EQUAL PARTS OF CEMENT AND SAND, MIXED FRESH EVERY 30 MINUTES AND KEPT WELL STIRRED IN THE BUCKET. THIS MIXTURE IS THROWN FORCIBLY AGAINST THE SURFACE TO BE FINISHED. THE TREATMENT MUST BE APPLIED WHILE THE FINISHING COAT IS STILL MOIST AND BEFORE IT HAS OBTAINED ITS FINAL SET, I.E. - WITHIN 3 TO 5 HOURS.



THE METHOD OF FINISHING THE COAT SHOULD BE SUCH THAT THE FINISH IS  
THE COAT TO BE FINISHED WITH A BRUSH OR ROLLER. IT IS ALSO  
ADVISED TO USE THE BRUSH OR ROLLER TO APPLY THE COAT TO THE  
SURFACE OF THE COAT. THE COAT SHOULD BE APPLIED IN SUCH A MANNER  
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SPLATTER DASH OR ROUGH CAST - AFTER THE FINISHING COAT HAS BEEN BROUGHT TO A SMOOTH SURFACE AND BEFORE ATTAINING ITS FINAL SET, IT IS UNIFORMLY COATED WITH A MIXTURE OF 1 PART CEMENT AND 2 PARTS OF SAND THROWN FORCIBLY AGAINST IT TO PRODUCE A ROUGH SURFACE OF UNIFORM TEXTURE WHEN VIEWED FROM A DISTANCE OF 20 FEET. SPECIAL CARE MUST BE TAKEN TO PREVENT THE RAPID DRYING OUT OF THIS FINISH.

PEBBLE DASH. - AFTER THE FINISHING COAT HAS BEEN BROUGHT TO A SMOOTH, EVEN SURFACE AND BEFORE ATTAINING INITIAL SET, CLEAN ROUND PEBBLES, OR OTHER MATERIAL AS SELECTED, NOT SMALLER THAN 1/4" OR LARGER THAN 3/4" PREVIOUSLY WETTED ARE THROWN FORCIBLY AGAINST THE MORTAR SO AS TO EMBED THEMSELVES IN THE FRESH MORTAR. THEY SHOULD BE DISTRIBUTED UNIFORMLY OVER THE SURFACE AND MAY BE PUSHED BACK INTO THE MORTAR WITH A CLEAN WOODEN TROWEL BUT NO RUBBING OF THE SURFACE SHOULD BE DONE AFTER THE PEBBLES ARE EMBEDDED.

MORTAR COLORS.

NOT MORE THAN 6% OF THE WEIGHT OF PORTLAND CEMENT SHOULD BE ADDED TO THE MORTAR IN THE FORM OF FINELY GROUND COLORING MATTER. ONLY PURE MINERAL PIGMENTS SHOULD BE USED. THE TINTS CAN BE VARIED BY USING DIFFERENT PROPORTIONS OF THE SAME PIGMENT. COLORS ARE DARKER WHEN THE CONCRETE IS WET AND ARE LIKELY TO GROW SOMEWHAT LIGHTER WITH AGE. WHITE PORTLAND CEMENT IS SOMETIMES USED TO OBTAIN VARIATION IN TINTS.

THE FOLLOWING TABLE WILL SERVE AS A GUIDE AS TO QUANTITY OF COLORING MATERIAL TO USE.

| COLOR OF<br>HARDENED<br>MORTAR | MINERAL                              | POUND OF<br>COLOR PER<br>SACK OF CEMENT |
|--------------------------------|--------------------------------------|-----------------------------------------|
| GRAY                           | GERMANTOWN; LAMPBLACK*               | 1/2                                     |
| BLACK                          | EXCELSIOR CARBON BLACK               | 3                                       |
| BLUE                           | ULTRAMARINE BLUE                     | 5                                       |
| GREEN                          | ULTRAMARINE GREEN                    | 6                                       |
| RED                            | IRON OXIDE                           | 6                                       |
| BROWN                          | ROASTED IRON OXIDE OR<br>BROWN OCHRE | 6                                       |
| BUFF                           | YELLOW OCHRE                         | 6                                       |

\* ORDINARY LAMPBLACK FADES AND RUNS. THE ULTRAMARINES FADE OUR UNIFORMLY. MOST HIGH GRADE PIGMENTS PRODUCE PRACTICALLY PERMANENT COLORS.

THE COLORS SHOULD BE MIXED WITH THE CEMENT BEFORE THE SAND IS ADDED.



**Final Coat** - After the finishing coat has been brought to a smooth surface and before attaining its final set, it is thoroughly coated with a mixture of 1 part cement and 5 parts of sand through a sieve. Against it is produced a uniform texture when viewed from a distance of 50 feet. Special care must be taken to prevent the rapid drying out of this finish.

**Final Coat** - After the finishing coat has been brought to a smooth even surface and before attaining its final set, clear round pebbles, of other material as selected, not smaller than 1/8" or larger than 3/4", are uniformly wetted and thrown forcibly against the mortar so as to embed themselves in the fresh mortar. They should be distributed uniformly over the surface and may be thrown back into the mortar with a clean wooden trowel but no rubbing of the surface should be done after the pebbles are embedded.

### Mortar Colors

Not more than 5% of the weight of Portland Cement should be added to the mortar in the form of finely ground coloring matter. Only pure mineral pigments should be used. The tint can be varied by using different proportions of the same pigment. Colors are darker when the cement is wet and are likely to fade somewhat lighter with age. White Portland Cement is sometimes used to obtain variation in tint.

The following table will serve as a guide as to quantity of coloring material to use.

| Color of Mortar | Mineral                           | Pounds of coloring material per bag of cement |
|-----------------|-----------------------------------|-----------------------------------------------|
| Gray            | Cementum; Lay-Black*              | 1/2                                           |
| Black           | Exquisite Carbon Black            | 3                                             |
| Blue            | Ultramarine Blue                  | 5                                             |
| Green           | Ultramarine Green                 | 8                                             |
| Red             | Iron Oxide                        | 5                                             |
| Brown           | Colored Iron Oxide or Brown Oxide | 2                                             |
| White           | Yellow Oxide                      | 5                                             |

\* Generally Lay-Black is used and mixed. The ultramarine is made the same. Lay-Black is a high grade pigment which produces permanent colors.

The colors should be mixed with the cement before the sand is added.



QUANTITY OF STUCCO.

IN ESTIMATING THE QUANTITY OF MATERIALS REQUIRED FOR STUCCO ALLOWANCE MUST BE MADE FOR FORMING KEYS BEHIND THE LATH. MORE MORTAR IS REQUIRED ON METAL LATH THAN ON WOOD LATH AND LESS MORTAR IS REQUIRED WHEN THE STUCCO IS APPLIED DIRECTLY TO AN EVEN MASONRY SURFACE. THE FOLLOWING WILL SERVE AS A GUIDE IN ESTIMATING THE AMOUNT OF MATERIALS REQUIRED.

4 SACKS CEMENT, 12 CU. FT. SAND AND 40 POUNDS HYDRATED LIME WILL COVER ABOUT 40 SQ. YDS. ABOUT  $\frac{3}{8}$  INCHES THICK.

4 SACKS CEMENT, 10 CU. FT. SAND AND 40 POUNDS OF HYDRATED LIME WILL COVER ABOUT 51 SQ. YDS. ABOUT  $\frac{1}{4}$  INCH THICK.

IN ORDINARY STUCCO WORK 1 MAN AND TWO HELPERS CAN FINISH 20 TO 25 SQ. YDS. 3 COAT WORK PER DAY.

ANOTHER WAY OF ESTIMATING THE LABOR IS THE 1 MAN AND HELPER CAN APPLY 10 TO 13 SQ. YDS. PER HOUR OF 1ST COAT

9 TO 11 " " " " " 2ND COAT

4 TO 6 " " " " " SAND OR ROUGH COAT FINISH.

FURTHER INFORMATION RELATIVE TO STUCCO CAN BE OBTAINED FROM TRADE CATALOGUES AND BELOW IS A PARTIAL LIST OF SOURCES FROM WHICH SUCH INFORMATION IS PROBABLY OBTAINABLE. MENTION OF THESE FIRMS DOES NOT IMPLY ANY PARTICULAR ENDORSEMENT BY THE DEPARTMENT OF EITHER THE PRICES OR QUALITY OF THEIR PRODUCTS.

THE ATLAS PORTLAND CEMENT ASSOCIATION, NEW YORK, N. Y.

NATIONAL LIME ASSOCIATION, 918 G. ST., N.W., WASHINGTON, D. C.

WICKSHIRE SPENCER STEEL CORPORATION, BUFFALO, N. Y.

ASSOCIATED METAL LATH MFGRS. INC., 123 W. MADISON ST., CHICAGO, ILL.

MAGNESITE STUCCO.

U. S. MATERIALS CO., WEED ST. AND SHEFFIELD AVE., CHICAGO, ILL.

HACHMEISTER-LIND CHEMICAL CO., PITTSBURGH, PA.

THE MECHANICALLY APPLIED PRODUCTS CO., 323-4 BULKLEY BLVD., CLEVELAND, OHIO.

NATIONAL KELLASTONE CO., 155 E. SUPERIOR ST., CHICAGO, ILL.

FRANKLYN B. MULLER & CO., 900 MADISON ST., WAUKEGAN, ILL.

WALL BOARD AND SHEATHING.

U. S. GYPSUM CO., 205 W. MONROE ST., CHICAGO, ILL.

SISHOPRIC MFG. CO., 300 ESTE AVENUE, CINCINNATI, OHIO.

ACME CEMENT PLASTER CO., ST. LOUIS, MO.







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING  
(EXTRACT FROM THE REPORT OF THE COMMISSIONER OF  
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JUNE, 1924.

CULTIVATORS.

CULTIVATORS OR HORSE-HOES, AS THEY WERE CALLED BY ENGLISH FARMERS, WERE IN USE IN ENGLAND IN THE VERY BEGINNING OF THE EIGHTEENTH CENTURY. THEY WERE USED IN THE CULTIVATION OF VARIOUS KINDS OF CROPS PLANTED IN ROWS OR DRILLS, ESPECIALLY THE SMALL CEREALS, AS WHEAT, BARLEY, AND OATS, LEGUMINOUS PLANTS AND SUCCULENT ROOTS. THESE BEING PLANTED OR SOWN IN DRILLS, AT EQUAL DISTANCES FROM SIX TO TWELVE INCHES APART, BY THE USE OF THIS MACHINE A NUMBER OF ROWS COULD BE CULTIVATED AT A TIME BY HAVING A SHARE SO ADJUSTED AS TO FIT THE INTERVAL BETWEEN THE ROWS. THE HORSE-HOE OF THAT PERIOD POSSESSED ALL THE ESSENTIAL ELEMENTS OF THE STRADDLE-ROW CULTIVATOR OF THIS DAY AND COUNTRY, AND THE CHANGES IT HAS UNDERGONE ON THIS SIDE OF THE ATLANTIC HAVE SIMPLY ADAPTED IT TO THE CULTIVATION OF MAIZE OR INDIAN CORN.

JETHRO TULL, AN ENGLISH FARMER WHO FLOURISHED IN THE EARLY PART OF THE LAST CENTURY, MAY JUSTLY BE CALLED THE PIONEER OF THE CONSTRUCTION AND USE OF THIS CLASS OF IMPLEMENTS. THE FOLLOWING EXTRACT FROM THE COMPLETE FARMER, PUBLISHED IN LONDON, ENGLAND, IN 1807 WILL SERVE TO GIVE A VERY CORRECT IDEA OF THE STATE OF THE ART AT THE PERIOD REFERRED TO:

"HORSE-HOE, A VERY POWERFUL TOOL OF THE HOE KIND, WHICH IS MUCH EMPLOYED IN THE CULTIVATION OF CROPS THAT ARE SOWN OR PLANTED IN THE DRILL OR ROW METHOD, WITH SUFFICIENTLY LARGE INTERVALS. THESE, LIKE THE HAND SORT, ARE OF VERY DIFFERENT FORMS AND CONSTRUCTIONS ACCORDING TO THE USES FOR WHICH THEY ARE DESIGNED; AND LIKEWISE VARY MUCH IN THEIR WEIGHT AND SIZE, AS WELL AS THE SHAPE OF THE HOES OR CUTTING PARTS. THESE SORTS OF HOES, FROM THEIR EXECUTING THE WORK, WHEN CONSTRUCTED FOR THE PURPOSE, ON A NUMBER OF ROWS AT THE SAME TIME, HAVE MUCH SUPERIORITY IN POINT OF DISPATCH, AS WELL AS IN PERFORMING THE OPERATION TO A GREATER DEPTH AND IN A MORE PERFECT MANNER, OVER THOSE OF THE HAND KIND. AS BY MEANS OF THESE HOES THE MOLD CAN BE MORE EFFECTUALLY STIRRED ABOUT THE PLANTS AND THE LAND KEPT MORE CLEAR AND FREE FROM WEEDS, THEY SHOULD BE MORE CONSTANTLY EMPLOYED WHENEVER THE NATURE OF THE CROP AND THE METHOD IN WHICH IT HAS BEEN SOWN ADMIT, AS SAVING MUCH LABOR AND EXPENSE, AS WELL AS EXECUTING THE BUSINESS IN A FAR MORE EFFICIENT MANNER."

WE LEARN FROM THE SAME WORK THAT EVEN EXPANDING HORSE-HOES WERE THEN IN USE, AND IN CONSTRUCTION WERE ADAPTED TO WORK IN DRILLS OF DIFFERENT WIDTHS, THAT IS TO SAY, THE BEARING WHEELS WERE ADJUSTABLE UPON THE AXLE IN SUCH A MANNER AS TO ACCOMMODATE THE SPACE BETWEEN THE ROWS OF VARIOUS CROPS, AS WHEAT, BARLEY, BEANS, TURNIPS, CABBAGE, ETC. DRILL MACHINES, WHICH HAVE BEEN LONG IN USE, WERE CONVERTED INTO HORSE-HOES BY REMOVING THE DRILL TEETH AND SUBSTITUTING CULTIVATING SHARES, AND SO ADJUSTING THEM AS TO FIT THE SPACES BETWEEN THE ROWS OF GROWING PLANTS. IT WAS ALSO DISCOVERED THAT SOILS OF DIFFERENT TEXTURES WILL REQUIRE TO BE HOED WITH SHARES OF DIFFERENT FORM AND SIZE, AND THAT NOTHING BUT EXPERIENCE IN THE FIELD CAN POINT OUT THAT WHICH IS BEST ADAPTED TO ANY PARTICULAR SOIL.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
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June, 1911

Information Series No. 55

CULTIVATORS

CULTIVATORS OR HORSEHOES, AS THEY WERE CALLED BY ENGLISH FARMERS, WERE IN USE IN ENGLAND IN THE VERY BEGINNING OF THE EIGHTEENTH CENTURY. THEY WERE USED IN THE CULTIVATION OF VARIOUS KINDS OF CROPS PLANTED IN ROWS OR GRILLS, ESPECIALLY THE SMALL CEREALS, AS WHEAT, BARLEY, AND OATS, LEGUMINOUS PLANTS AND SUGARCANE ROOTS. THESE BEING PLANTED IN ROWS OR GRILLS AT EQUAL DISTANCES FROM SIX TO TWELVE INCHES APART, BY THE USE OF THIS MACHINE A NUMBER OF ROWS COULD BE CULTIVATED AT A TIME BY HAVING A SHARE SO ADJUSTED AS TO FIT THE INTERVAL BETWEEN THE ROWS. THE HORSEHOE OR THAT PERIOD POSSESSED ALL THE ESSENTIAL ELEMENTS OF THE MODERN CULTIVATOR OF THIS DAY AND COUNTRY, AND THE CHANGES IT HAS UNDERGONE ON THIS SIDE OF THE ATLANTIC HAVE SIMPLY ADAPTED IT TO THE CULTIVATION OF MAIZE OR INDIAN CORN.

ALTHOUGH FULL, AN ENGLISH FARMER WHO FLOURISHED IN THE EARLY PART OF THE LAST CENTURY, MAY JUSTLY BE CALLED THE PIONEER OF THE CONSTRUCTION AND USE OF THIS CLASS OF IMPLEMENTS. THE FOLLOWING EXTRACT FROM THE QUARTERLY FARMER, PUBLISHED IN LONDON, ENGLAND, IN 1807 WILL SERVE TO GIVE A VERY CORRECT IDEA OF THE STATE OF THE ART AT THE PERIOD REFERRED TO:

"HORSEHOES, A VERY POWERFUL TOOL OF THE HOB KIND, WHICH IS MUCH EMPLOYED IN THE CULTIVATION OF CROPS THAT ARE SOWN OR PLANTED IN THE DRILL OR ROW METHOD, WITH SUFFICIENTLY LARGE INTERVALS. THESE, LIKE THE HAND SORT, ARE OF VERY DIFFERENT FORMS AND CONSTRUCTIONS ACCORDING TO THE USES FOR WHICH THEY ARE DESIGNED; AND LIKEWISE VARY MUCH IN THEIR WEIGHT AND SIZE, AS WELL AS THE SHAPE OF THE HOES OR CUTTING PARTS. THESE SORTS OF HOES, FROM THEIR EXECUTING THE WORK, WHEN CONSTRUCTED FOR THE PURPOSE, ON A NUMBER OF ROWS AT THE SAME TIME, HAVE MUCH SIMILARITY IN POINT OF CONSTRUCTION, AS WELL AS IN PERFORMING THE OPERATION TO A GRATEFUL DEGREE AND IN A MORE PERFECT MANNER, OVER THOSE OF THE HAND KIND, AS BY MEANS OF THESE HOES THE MOULD CAN BE MORE EFFECTUALLY STIRRED ABOUT THE PLANTS AND THE LAND KEPT MORE CLEAR AND FREE FROM WEEDS. THEY SHOULD BE MORE CONSTANTLY EMPLOYED WHENEVER THE NATURE OF THE CROPS AND THE METHOD IN WHICH IT HAS BEEN SOWN ADMITS, AS SAVING MUCH LABOR AND EXPENSE, AS WELL AS EXECUTING THE BUSINESS IN A FAR MORE EFFICIENT MANNER."

WE LEARN FROM THE SAME WORK THAT EVEN EXPANDING HORSEHOES WERE THEN IN USE, AND IN CONSTRUCTION WERE ADAPTED TO WORK IN DRILLS OR DRILLING WHIRLS, THAT IS TO SAY, THE BEARING WHEELS WERE ADJUSTABLE UPON THE AXLE IN SUCH A MANNER AS TO ACCOMMODATE THE SPACE BETWEEN THE ROWS OF VARIOUS CROPS, AS WHEAT, BARLEY, BEANS, TURNIPS, CABBAGES, ETC. DRILL MACHINES, WHICH HAVE BEEN LONG IN USE, WERE CONVERTED INTO HORSEHOES BY REMOVING THE DRILL TUBES AND SUBSTITUTING CULTIVATING SHARES, AND SO ADJUSTING THEM AS TO FIT THE SPACES BETWEEN THE ROWS OF SOWING PLANTS. IT WAS ALSO DISCOVERED THAT COALS OR DIFFERENT TEXTURES WOULD REQUIRE TO BE HOED WITH SHARES OF DIFFERENT FORM AND SIZE, AND THAT NOTHING BUT EXPERIENCE IN THE FIELD CAN POINT OUT THAT WHICH IS BEST ADAPTED TO ANY PARTICULAR SOIL.



IN LOUDON'S ENCYCLOPEDIA OF AGRICULTURE, SIXTH EDITION, PAGE 125, WE HAVE THE FOLLOWING STATEMENT:

"IN ENGLAND, FROM THE RESTORATION OF THE MIDDLE OF THE EIGHTEENTH CENTURY, VERY LITTLE IMPROVEMENT TOOK PLACE, EITHER IN THE CULTIVATION OF THE SOIL OR IN THE MANAGEMENT OF LIVE STOCK. EVEN CLOVER AND TURNIPS (THE GREAT SUPPORT OF THE PRESENT IMPROVED SYSTEM OF AGRICULTURE) WERE CONFINED TO A FEW DISTRICTS, AND AT THE CLOSE OF THIS PERIOD WERE SCARCELY CULTIVATED AT ALL BY COMMON FARMERS IN THE NORTHERN PARTS OF THE ISLAND. FROM THE WHOLE ART OF HUSBANDRY, PUBLISHED BY MORTIMER IN 1706, A WORK OF CONSIDERABLE MERIT, IT DOES NOT APPEAR THAT ANY IMPROVEMENT WAS MADE ON HIS PRACTICES TILL NEAR THE END OF THE LAST CENTURY. IN THOSE DISTRICTS WHERE CLOVER AND RYE-GRASS WERE CULTIVATED, THEY WERE CUT GREEN AND USED FOR SOILING AS AT PRESENT. TURNIPS WERE SOWN BROADCAST, HAND-HOED, AND USED FOR FEEDING SHEEP AND CATTLE, AS THEY WERE USED IN HOUGHTON'S TIME, AND ARE STILL IN MOST DISTRICTS OF ENGLAND."

"IN THE BEGINNING OF THE EIGHTEENTH CENTURY A CONSIDERABLE IMPROVEMENT IN THE PROCESS OF CULTURE WAS INTRODUCED BY JETHRO TULL, A CULTIVATOR OF BERKSHIRE, WHO BEGAN TO DRILL WHEAT AND OTHER CROPS ABOUT THE YEAR 1701, AND WHOSE HORSE-HOEING HUSBANDRY WAS PUBLISHED IN 1731. IN GIVING A SHORT ACCOUNT OF THE VIEWS OF THIS ECCENTRIC WRITER, IT IS NOT MEANT TO ENTER INTO ANY DISCUSSION OF THEIR MERITS. IT WILL NOT DETRACT MUCH FROM HIS REPUTATION TO ADMIT THAT, LIKE MOST OTHER MEN WHO LEAVE THE BEATEN PATH, HE WAS SOMETIMES MISLED BY INEXPERIENCE AND SOMETIMES DECEIVED BY A TOO SANGUINE IMAGINATION. HAD TULL CONFINED HIS RECOMMENDATIONS OF DRILL HUSBANDRY TO LEGUMINOUS AND BULBOUS-ROOTED PLANTS GENERALLY, AND TO THE CEREAL GRAMINA ONLY IN PARTICULAR CIRCUMSTANCES; AND HAD HE, WITHOUT PUZZLING HIMSELF ABOUT THE FOOD OF PLANTS, BEEN CONTENTED WITH POINTING OUT THE GREAT ADVANTAGE IN PULVERIZING THE SOIL IN MOST CASES, AND EXTERMINATING WEEDS IN EVERY CASE, HE WOULD CERTAINLY HAVE DESERVED A HIGH RANK AMONG THE BENEFACTORS OF HIS COUNTRY. A KNOWLEDGE OF HIS DOCTRINES AND PRACTICE, HOWEVER, WILL SERVE AS A NECESSARY INTRODUCTION TO THE PRESENT APPROVED MODES OF CULTURE. THE EXTRAORDINARY ATTENTION TULL GAVE TO HIS MODE OF CULTURE IS, PERHAPS WITHOUT A PARALLEL. "I WAS FORMERLY AT MUCH PAINS", HE SAYS, "AND AT SOME CHARGE, IN IMPROVING MY DRILLS FOR PLANTING THE ROWS AT VERY NEAR DISTANCES, AND HAD BROUGHT THEM TO SUCH PERFECTION THAT ONE HORSE WOULD DRAW A DRILL WITH ELEVEN SHARES, MAKING THE ROWS THREE INCHES AND A HALF DISTANT FROM ONE ANOTHER, AND AT THE SAME TIME SOW IN THEM THREE VERY DIFFERENT SORTS OF SEEDS, WHICH DID NOT MIX, AND THESE, TOO, AT DIFFERENT DEPTHS."

IT WILL BE SEEN BY THESE QUOTATIONS THAT THE BROAD IDEA OF CULTIVATING MORE THAN ONE ROW OF PLANTS AT A TIME BY HORSE-POWER DID NOT ORIGINATE IN THIS COUNTRY. WHAT, THEN, ARE THE IMPROVEMENTS IN THIS IMPLEMENT CLAIMED BY AMERICAN INVENTORS? PERHAPS THE FIRST AND MOST IMPORTANT IS THE PROVISION OF A DRIVER'S SEAT UPON THE FRAME OF THE MACHINE, AND THE ADAPTATION OF THE CULTIVATING DEVICES BY WHICH THEY WERE BROUGHT WITHIN THE PERFECT CONTROL AND GUIDANCE OF THE OPERATOR. INVENTION DOES NOT OFTEN MAKE GIGANTIC STRIDES; AND HENCE WE SEE THAT LITTLE BY LITTLE HAS BEEN ADDED TO THE ORIGINAL IDEA, AND IT IS UNDER THIS INFLUENCE THAT FARMERS HAVE REACHED THE HIGH STANDARD NOW PRESENTED IN CULTIVATORS.



in London's Encyclopedia of Agriculture, sixth edition, page 455.  
WE HAVE THE FOLLOWING STATEMENT:

"In England, from the restoration of the middle of the eighteenth century, very little improvement took place, either in the cultivation of the soil or in the management of live stock. Even clover and turnips (the great support of the present improved system of agriculture) were confined to a few districts, and at the close of this period were scarcely cultivated at all by common farmers in the northern parts of the island. From the whole art of husbandry, published by Whittaker in 1796, a work of considerable merit, it does not appear that any improvement was made on his practice till near the end of the last century. In those districts where clover and turnips were cultivated, they were cut green and used for feeding as at present. Turnips were sown broadcast, and used for feeding sheep and cattle, as they were used in Houghton's time, and are still in most districts of England."

"In the beginning of the eighteenth century a considerable improvement in the process of culture was introduced by Jethro Tull, a cultivator of Berkshire, who was in to drill wheat and other crops about the year 1701, and whose interesting husbandry was published in 1731. In giving a short account of the views of this eccentric writer, it is not meant to enter into any discussion of their merits. It will not detract much from his reputation to admit that, like most other men who leave the beaten path, he was sometimes misled by inexperience and sometimes deceived by a too sanguine imagination. Had Tull conceived his recommendations of drill husbandry to be luminous and successful, he would have been generally, and to the great advantage of the world, soon followed; and had he, without pulling himself about the food of plants, been contented with pointing out the great advantage in pulverizing the soil in most cases, and extending these in every case, he would certainly have deserved a high rank among the benefactors of his country. A knowledge of his doctrines and practice, however, will serve as a necessary introduction to the present approved mode of culture. The extraordinary attention Tull gave to his mode of culture is, perhaps without a parallel. "I was formerly at much pains," he says, "and at some charge, in improving my drills for planting the rows at very narrow distances, and had brought them to such perfection that one horse would draw a drill with eleven shares, making the rows three inches and a half distant from one another, and at the same time sow in three very different sorts of seeds, which did not mix, and these, too, at different depths."

It will be seen by these quotations that the broad idea of cultivating more than one row of plants at a time by horsepower did not originate in this country. What, then, are the improvements in this method claimed by American inventors? Perhaps the first and most important is the provision of a driver's seat upon the frame of the machine, and the adaptation of the cultivating device by which they were brought within the perfect control and guidance of the operator. Invention does not often make gigantic strides; and hence we see that little by little had been added to the original idea, and it is under this influence that farmers have reached the high standard now presented in cultivation.



THIRTY YEARS AGO, A MAN WITH A HAND-HOE COULD, BY THE AID OF A HORSE AND PLOW, FOR PLOWING FURROWS BETWEEN THE ROWS OF CORN, CULTIVATE AN ACRE IN A DAY. NOW, WITH A SPAN OF HORSES, AND ONE OF OUR BEST RIDING CULTIVATORS, FIFTEEN ACRES CAN BE ACCOMPLISHED, AND THIS WITH ALMOST AS MUCH EASE AND COMFORT AS A DAY'S JOURNEY IN A BUGGY.

IN LOOKING BACK OVER THE LAST THIRTY YEARS, AND TRACING FROM YEAR TO YEAR THE IMPROVEMENTS THAT HAVE BEEN MADE IN THIS IMPLEMENT, TO MORE PERFECTLY ADAPT IT TO THE CULTIVATION OF MAIZE, OR INDIAN CORN, IT WOULD SEEM THAT THIS MACHINE HAD ALMOST REACHED PERFECTION, AND THAT THERE IS LITTLE MORE THAT IS DESIRABLE. LOOKING AT THE SUBJECT FROM ANOTHER STAND-POINT, HOWEVER, WE ARE FORCED TO ACKNOWLEDGE THAT THE FIELD FOR ADVANCEMENT IS CONSTANTLY ENLARGING, AND THAT EVERY NEW IMPROVEMENT INTRODUCED ONLY WIDENS THE AREA FOR OTHERS.

LET ANY ONE TRACE THE SUCCESSIVE STEPS THAT HAVE BEEN TAKEN, FROM THE INITIATIVE IDEA OF JETHRO TULL, IN THE YEAR 1701, TO THE PRESENT TIME, AND CONSIDER IN THIS CONNECTION THE LIBERAL POLICY OF THE GOVERNMENT IN GRANTING PROTECTION FOR IMPROVEMENT IN ART, AND HE WILL BE NO LONGER IN DOUBT AS TO THE CAUSE OF THE ISSUE OF SO MANY PATENTS FOR IMPROVEMENTS IN THIS AND KINDRED INVENTIONS.



THIRTY YEARS AGO, A MAN WITH A HANDSOME COULD, BY THE USE OF A  
HORSE AND PLOW, FOR FLOWING FORDS BETWEEN THE HARE OF CORN, CULTI-  
VATE AN ACRE IN A DAY. NOW, WITH A SPAN OF HORSES, AND ONE OF OUR  
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GRANTING PROTECTION FOR IMPROVEMENT IN ART, AND HE WILL BE NO LONGER IN  
DOUBT AS TO THE CAUSE OF THE ISSUE OF SO MANY PATENTS FOR IMPROVEMENTS  
IN THIS AND KINDRED INVENTIONS.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF AGRICULTURAL ENGINEERING  
DIVISION OF MECHANICAL EQUIPMENT

Information Series No. 52 (Revised August, 1935)

HISTORY OF CULTIVATORS

Compiled by Lillian Church, Senior Clerk

"The original cultivator was, like the original plow, simply a hooked stick. This in time was developed into the hoe, and remained the common cultivating implement until this century (19th) was well advanced." (5p. 354) 1/

It is stated in the 1860 Census, (9, p.xxv) that "The first American patent for improvement in hoes was registered in 1819, and for cast steel hoes in 1827, by C. Bulkley, of Colchester, Connecticut, but cast steel hoes were made in Philadelphia by at least two manufacturers in 1823." Mention is also made by the same authority of the manufacture of "scythes, sickles, hoes, shovels, and other hardware in considerable amount previous to 1803," in Pittsburgh, Pennsylvania. It is also stated that "on account of the fall in the price of iron and steel, superior steel hoes were made in Pittsburgh in 1831 for about \$4.50 per dozen, or one-half the price of iron hoes ten years before." The demand for hoes seems to have increased prior to the invention of the cultivator, as it is also stated that 1,600 dozen steel hoes were manufactured in two establishments in Pittsburgh in 1836, and that 32,000 dozen of hoes and 11,000 dozen of planters' hoes were made in four establishments in the same city in 1857.

As late as the first decade of the 19th century not only was the hoe used in the cultivation of row crops, but in some sections of the South, notably the lower parts of South Carolina, according to Leo Rogin, (8, p.53) "The hoe was the principal instrument of husbandry, being employed almost to the exclusion of the plow for Indian corn and cotton." Rogin quotes the English traveler, Olmstead, as saying, referring to the coastal regions of the Carolinas and Georgia, "As late as 1853" \*\*\*\*\* "the clumsy iron hoe is almost everywhere made to do the work of pick, spade, shovel and plow. I have seen it used to dig a grave. On many plantations a plow has never been used; the land being entirely prepared for the crop by chopping with the hoe." Another writer about a decade later stated that on the coast of South Carolina the cultivation of corn was still carried on entirely with hoes.

Cultivating a considerable acreage with a hoe was a very tedious process, and inventors used their knowledge and skill in attempting to devise a machine that would more quickly and easily accomplish the desired result. One writer has said that "Next to the plow in importance to the farmer is, undoubtedly,

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1/ Underlined numbers in parenthesis refer to the list of references on page 9.



the cultivator, an implement that has taken the place of the old-fashioned hand-hoe in the cultivation of such plants as are grown in rows. By the use of this implement a man with a span of horses is able to do the work of 10 or 15 men operating with the hand-hoe, especially in the cultivation of maize or Indian corn." (11)

It appears that a form of cultivator was used in England before they were introduced in the United States, as will be seen by the following quotation from the report cited just above. "Cultivators or horse-hoes, as they were called by English farmers, were in use in England in the very beginning of the eighteenth century. They were used in the cultivation of various kinds of crops planted in rows or drills, especially the small cereals, as wheat, barley, and oats, leguminous plants and succulent roots. These being planted or sown in drills, at equal distances from 6 to 12 inches apart, by the use of this machine a number of rows could be cultivated at a time by having a share so adjusted as to fit the interval between the rows. The horse-hoe of that period possessed all the essential elements of the straddle-row cultivator of this day and country, and the changes it has undergone on this side of the Atlantic have simply adapted it to the cultivation of maize or Indian corn." (11, p.397)

There seems to be some disagreement among writers as to the first inventor of a cultivator, as will be seen by the two following statements:

"Wilkie, of Scotland, is the inventor of the cultivator. In 1820 he invented the plurality of shares, the expanding frame and the caster wheel" (3, p.3).

"Jethro Tull, an English farmer who flourished in the early part of the last (18th) century, may justly be called the pioneer in the construction and use of this class of implements." (11, pp.397-398) The same author continues as follows:

"The following extract from the Complete Farmer, published in London, England, in 1807 will serve to give a very correct idea of the state of the art at the period referred to:

'Horse-Hoe, a very powerful tool of the hoe kind, which is much employed in the cultivation of crops that are sown or planted in the drill or row method, with sufficiently large intervals. These, like the hand sort, are of very different forms and constructions according to the uses for which they are designed; and likewise vary much in their weight and size, as well as the shape of the hoes or cutting parts. These sorts of hoes, from their executing the work, when constructed for the purpose, on a number of rows at the same time, have much superiority in point of dispatch, as well as in performing the operation to a greater depth and in a more perfect manner, over those of the hand kind. As by means of these hoes the mold can be more effectually stirred about the plants and the land kept more clear and free from weeds, they should be more constantly employed whenever the nature of the crop and the method in which it has been sown admit, as saving much labor and expense, as well as executing the business in a far more efficient manner.'

'We learn from the same work that even expanding horse-hoes were then in use, and in construction were adapted to work in drills of different widths,



that is to say, the bearing wheels were adjustable upon the axle in such a manner as to accommodate the space between the rows of various crops, as wheat, barley, beans, turnips, cabbage, etc. Drill machines, which have been long in use, were converted into horse-hoes by removing the drill teeth and substituting cultivating shares, and so adjusting them as to fit the spaces between the rows of growing plants. It was also discovered that soils of different textures will require to be hoed with shares of different form and size, and that nothing but experience in the field can point out that which is best adapted to any particular soil."

"The cultivator, introduced about 1820, had largely supplanted by 1840 the plow and the hand-hoe on eastern farms in working between the rows of corn. The new machines were cheap, costing only \$15. or \$20., and although clumsy and heavy according to modern standards they were much lighter than plows, and by doing away with hoeing, saved much hand labor. It was estimated in 1826, that more corn could be tilled in a given time with one cultivator than with three plows." (2, pp. 210-212)

The Report of the Commissioner of Agriculture for 1870, pp.398-399, contains the following quotation from Loudon's Encyclopedia of Agriculture, sixth edition, p.125:

"In England, from the Restoration to the middle of the eighteenth century, very little improvement took place, either in the cultivation of the soil or in the management of live stock. Even clover and turnips (the great support of the present improved system of agriculture) were confined to a few districts, and at the close of this period were scarcely cultivated at all by common farmers in the northern parts of the island. From the Whole Art of Husbandry, published by Mortimer in 1706, a work of considerable merit, it does not appear that any improvement was made on his practices till near the end of the last century. In those districts where clover and rye-grass were cultivated, they were cut green and used for soiling as at present. Turnips were sown broadcast, hand-hoed, and used for feeding sheep and cattle, as they were used in Houghton's time, and are still in most districts of England."

"In the beginning of the eighteenth century a considerable improvement in the process of culture was introduced by Jethro Tull, a cultivator of Berkshire, who began to drill wheat and other crops about the year 1701, and whose Horse-Hoeing Husbandry was published in 1731. \*\*\*\*\* The extraordinary attention Tull gave to his mode of culture is, perhaps without a parallel. I was formerly at much pains, he says, and at some charge, in improving my drills for planting the rows at very near distances, and had brought them to such perfection that one horse would draw a drill with eleven shares, making the rows three inches and a half distant from one another, and at the same time sow in them three very different sorts of seeds, which did not mix, and these, too, at different depths.

"It will be seen by these quotations that the broad idea of cultivating more than one row of plants at a time by horse-power did not originate in this country. What, then, are the improvements in this implement claimed by American inventors? Perhaps the first and most important is the provision



of a driver's seat upon the frame of the machine, and the adaptation of the cultivating devices by which they were brought within the perfect control and guidance of the operator. Invention does not often make gigantic strides; and hence we see that little by little has been added to the original idea, and it is under this influence that farmers have reached the high standard now presented in cultivators.

"Thirty years ago, a man with a hand-hoe could, by the aid of a horse and plow, for plowing furrows between the rows of corn, cultivate an acre in a day. Now, with a span of horses, and one of our best riding cultivators, fifteen acres can be accomplished, and this with almost as much ease and comfort as a day's journey in a buggy.

"In looking back over the last thirty years, and tracing from year to year the improvements that have been made in this implement, to more perfectly adapt it to the cultivation of maize, or Indian corn, it would seem that this machine had almost reached perfection, and that there is little more that is desirable. Looking at the subject from another standpoint, however, we are forced to acknowledge that the field for advancement is constantly enlarging, and that every new improvement introduced only widens the area for others."

As corn planting was largely a hand operation in 1840, so also was cultivating that crop. "In 1840 corn in the East was cultivated with a hoe, or with an awkward and ineffective one-horse cultivator. The teeth, usually of cast iron, were fastened to the wooden frame with a short neck, rendering operation difficult on uneven land or where there were stumps and stones. The plow, for the cultivation of corn had gone out of use in the East. In the West the one-horse plow or the shovel plow were the implements commonly used for corn cultivation. Later, about 1850, another shovel had been added, and the double shovel plow became common. Three-shovel plows and steel-tooth cultivators were coming into use." (2, pp.302, 303)

By 1860 straddle-row cultivators of various types had appeared. The use of steel in the teeth greatly increased the efficiency of the implement. A great saving in man and horse labor was effected by the improvements in corn cultivators and planters in the years 1840 and 1860, and in addition there was a great improvement in the quality of work performed. The wheel cultivator was used in the wheat regions of western New York and eastern Ohio. It was considered of great utility in mellowing fallow land for wheat and destroying weeds. The machine had largely gone out of use by the late fifties." (2, pp. 302, 303) "In the West the amount of wheat which a farmer raised was determined by the acreage that he could effectively harvest. His corn crop was limited by the acreage that he could cultivate. Consequently, the introduction of reapers and cultivators was largely responsible for the rapid expansion of the area of production during this period. \*\*\*\*\* In 1860 2-row corn planters and 2-horse corn cultivators were being rapidly developed. The single-shovel plow had given way to the double-shovel plow. \*\*\*\*\* The Ohio farmer of 1860 who adopted the improved methods of production then available could probably produce his crops with two-thirds the labor required in 1840". The development of the 2-row riding cultivator followed the introduction of the 2-row, check-row corn planter. (2, p. 305)



"Various kinds of plows are in use for the cultivation of corn, single and double shovel, five tooth cultivators, 2-horse scrapers, and 2-horse, four-shovel plows. The scraper and 1-horse double-shovel plow are most in use." (7, p.64)

That many inventors were interested in the subject of cultivators is evidenced by the fact that of the 1,900 patents issued by the United States Patent Office in 1869, 150 were for cultivators. (10, p.315)

Carl R. Woodward (13, p.14) referring to cultivators in general, states that "The early reports of the United States Patent Office reveal some interesting facts about these machines. Some of them were equipped with wheels; others were without wheels, the weight of the machine resting upon the cultivator blades or plows. Some were equipped with a driver's seat; with others the operator walked behind."

Apparently the very first cultivators invented and used were not patented, as in (13, p.14) it is stated that "A hundred years ago in the tillage of corn on eastern farms the plow and the hand hoe were giving way to horse-drawn cultivators which had been introduced about 1820. These early 1-horse cultivators were much the same as the small cultivators of recent times, except that the A-shaped frame was of wood instead of iron, and certain devices for adjustment were lacking. Iron blades or teeth were fitted into the frame, and the implement was guided between the rows with a pair of handles similar to plow handles. For a number of years these cultivators occupied first place on New Jersey farms."

The first United States patent for a cultivator was issued to Borden in 1830, and the first wheel cultivator patent was granted in 1846. (3, p.3) This reference continues as follows: "The single shovel plow has been in use for many years; the double shovel is a later invention; it resembles some of the plows used for a thousand years or more in Asia and southern Europe. The double shovel is nearly perfect for the purpose for which it is used, viz: that of tending a crop which is planted in hills, such as corn or potatoes. The nearest approach to the American shovel plow is the Scotch horse hoe. The Scotch grubber is a heavy cultivator, drawn by four horses, and supported on wheels, for stirring and loosening the soil to plow depth. Cultivators are classed in the United States as ordinary, wheeled, rotary, straddle-row, parallel, disk, walking, riding, vineyard and expanding."

A patent was taken out in April, 1856, by George Esterly, of Wisconsin, the inventor of the grain header, according to Ardrey, (1, p.36) for a sulky cultivator having the shovels in separate gangs. The Esterly cultivator is referred to as a "curiosity in the cultivator line. \*\*\*\*\* Mr. Esterly dwelt largely upon the advantage afforded by his machine in following the row, no matter how crooked, and regularly cleaning and cultivating both sides of it as the operator passed along." (6, p.22)

A patent was issued in 1856 to H.D. Ganse of New Jersey, covering a cultivator having foot control of the gangs. In January, 1857, J. Shaw, of Georgia, secured a patent for a cultivator "in which the hoes or shovels



had a swivel adjustment to throw the dirt to and from the plants." In April 1857, N. Whitehall, of Indiana, patented a cultivator having an arched axle over the row, and "which also had an evener suspended upon three points." A drag fender, or shield, attached to the gangs on each side, was covered in the patent of N. Fraser and A.J. McClellan," dated August 10, 1858. (1, p.36)

"Straddle-row, or 2-horse cultivators, were introduced between 1850 and 1860." \*\*\*\*\* "One man with a 2-horse cultivator could do the work of two men with the old type of implement." The inventive minds of New Jersey about this time seem to have been focused on devising cultivators, or improvements on earlier models, as a number of patents were issued to citizens of that State, among which were the Smalley cultivator, patented in 1859, and the three so-called plows, known as the Rue, the Riggs and the Fisher. The Smalley machine "differed from others in the special combination of devices, particularly the placing of the seat so that the driver could raise and lower the cultivator teeth with a lever without dismounting." (13, p.14)

In the Fisher cultivator, patented in 1860, "the blades, which were in the form of small plows, were raised and lowered by means of a lever and chain attachment." In this cultivator the wheels were very high. Mr. Fisher improved his cultivator by providing a means for "widening or narrowing its main frame," a patent for which was issued in 1869. (13, p.14)

The Riggs plow, patented in 1861, "was not equipped with wheels, but consisted of two rows of plow-like blades fitted into an overhanging frame that straddled the row. It was operated by means of two handles extending to the rear. Riggs plows have been in use until fairly recent times, and may still be found on some farms." A patent for a furrowing sled, "typical of the implement in common use for corn planting the latter part of the nineteenth century" was issued to Mr. Riggs in 1864. (13, p.14)

The patent for James Rue's first cultivator was issued in 1859. That machine had neither wheels nor seat, and "adjustments were made by connections with the pole." A later patent, issued in 1872, covered a cultivator having a "heavy wooden frame and low wheels, the cultivator blades being raised and lowered by means of two levers. The pole was adjustable, and the driver walked behind, steering the machine by driving, and with the help of two horizontal handles." (13, p.14)

Another machine known as "Brown's cultivator, patented March 25, 1862, provided a gang of plows, attached to a mounted frame in such manner that the plows would rise and fall according to the inequalities of the surface of the ground. Their depth and distance apart also could be regulated." (13, p.14)

"A cultivator that anticipated the modern types of cultivators with flexible axles for steering, was patented by Edward Phifer, of New Jersey, June 30, 1868. The tongue, or pole, was pivoted on the frame to facilitate turning." (13, p.14)

Two patents were issued in 1873 to Oliver Kugler, covering cultivators, one of which is described as follows: "Concave scrapers are attached to runners, which converge in the rear. These are followed by shorter



scrapers or shares, which throw the clean soil toward the row of plants." The second patent is described thus: "A rectangular frame supported on runners, having inwardly projecting scraping wings on a rear cultivating attachment." Improvements were made and patented by Mr. Kugler in 1876. (14, p.14)

Other inventors of cultivators include James Dundas, of Illinois, who secured a patent in 1859, which was reissued in 1866, covering "six combination claims on the use of two wheels on a cultivator arranged with two gangs with a space between them, a seat for the driver, and means for moving the gangs laterally and raising the plows relatively to the treads of the wheels." (1, p.36)

B. Tinkham obtained a patent in 1860 in which he claimed "A beam hinged or pivoted to an axle by a joint, whereby the beams with their shovels had both a vertical and lateral swing in an upright position. It also claimed a rearward extension of the arched axle of the plow, with supports on it for holding up the gangs when not in operation." In 1862 L.B. Waterman, of Illinois, secured a patent "covering an adjustable seat." In 1863 J.A. Thorp and John Cox, of Michigan, obtained a patent on "the use of a yielding connection or wooden peg in the shank of the gang, so that the shovel might yield when it came against an obstruction that would otherwise break it." Another Illinois inventor was P. Coonrod, who in 1867 obtained a patent for "a coupling with a sleeve fitted on the axle." It is said that this "laid the foundation for the Brown and later patents using a sleeve or box." Three patents were issued to W.P. Brown, of Ohio. The one dated July 9, 1872, covered "spring arms and chains for suspending the weight of the shovel beams, substantially as and for the purposes described." The second patent was issued in 1877 "on a coupling and spring," and in 1879 another patent "covering details of what is known as the Brown coupling" was issued. (1, p.38)

In July, 1879, a patent was issued to G. Moore, of Illinois, "covering the use of a spring and coupling." \*\*\*\*\* "In December, 1879, E.A. Wright, of Iowa, patented a peculiar spring, the principle of it being to exert a lifting strain on the gang after it has been raised above its operating position, and to bear down on it, rather than lift it, while it is in the ground." A second patent was issued to Mr. Wright, in 1881, "covering more fully the principle of his double acting spring." (1, p.38)

Many adaptations of the standard type of cultivator have been made by inventors, for corn cultivation and other uses. "Disks in place of shovels have been introduced \*\*\*\*\* and meet with favor. Spring teeth \*\*\*\*\* have also come into favor. \*\*\*\*\* Within the past few years many styles of tongueless, walking cultivators have been put on the market by manufacturers, and have met with a favorable reception. They have the advantages of general convenience, light draft, flexibility in the frame so that the gangs can be held more steadily and nearer to the corn when it is small, and less room is required for turning at the side of the field." (1, pp.38-39)



Davidson and Chase, (4, p.91) state that "The modern cultivator, which is a very efficient aid to the cultivation of growing plants, has developed under the addition of animal power from a kind of crude hoe used in the early days. The original single shovel was changed for the double shovel, this in turn was supplanted by the straddle-row cultivator, and even the latter was increased in size until in some cases the modern cultivator will take two rows at a time. \*\*\*\*\* Until 1860 country blacksmiths generally made the double shovels used by farmers."

Following the development of the general purpose tractor, about 1924, appeared tractor cultivators. These became available in 2, 3, and 4-row sizes



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- (14) Woodward, Carl R.  
1929 More about tillage implements. New Jersey Agriculture. v. 11, no. 8. illus. New Brunswick, N.J.







THE FOLLOWING ARE THE

- Figure 1- A view of a type of a row crop machine in use in the United States.
- Figure 2- A view of a type of a row crop machine in use in the United States.
- Figure 3- A view of a type of a row crop machine in use in the United States.
- Figure 4- A view of a type of a row crop machine in use in the United States.
- Figure 5- A view of a type of a row crop machine in use in the United States.
- Figure 6- A view of a type of a row crop machine in use in the United States.
- Figure 7- A view of a type of a row crop machine in use in the United States.
- Figure 8- A view of a type of a row crop machine in use in the United States.
- Figure 9- A view of a type of a row crop machine in use in the United States.
- Figure 10- A view of a type of a row crop machine in use in the United States.

FARM MACHINES, OLD AND NEW IN PICTURES:

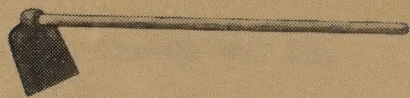
FOR CULTIVATING ROW CROPS



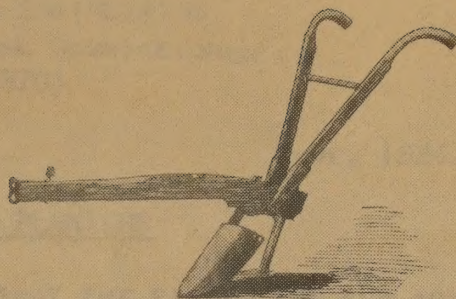
## FOR CULTIVATING ROW CROPS

- Figure 1.- The hoe.
- Figure 2.- A shovel plow of a type found in this country early in the 19th century.
- Figure 3.- Double-shovel plow which came into use in the United States as early as 1850.
- Figure 4.- An early type one-row, walking cultivator with wheels.
- Figure 5.- A single-row riding cultivator appeared just prior to the Civil War.
- Figure 6.- A modern two-row, horse-drawn, riding cultivator made possible by the use of 2-row, check-row planters. The development of this cultivator began about 1860.
- Figure 7.- A two-row cultivator mounted on a modern general-purpose tractor.

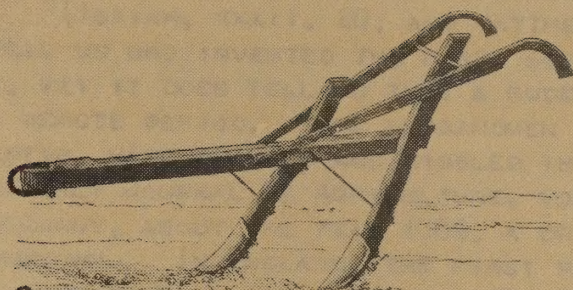




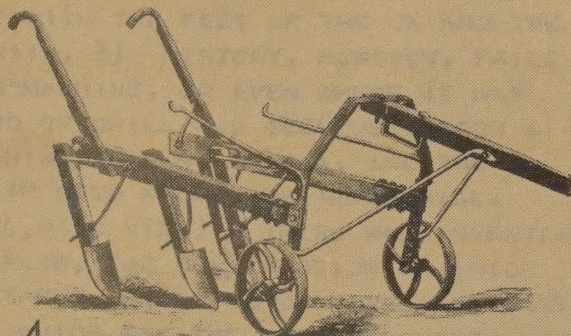
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UNITED STATES DEPARTMENT OF AGRICULTURE.  
BUREAU OF PUBLIC ROADS.  
DIVISION OF AGRICULTURAL ENGINEERING.  
(EXTRACT FROM THE REPORT OF THE COMMISSIONER OF  
AGRICULTURE FOR 1870)

INFORMATION SERIES No. 53.

JUNE, 1924.

GRAIN DRILLS AND CORN PLANTERS

FROM HISTORY WE ARE LED TO BELIEVE THAT THE FIRST, AND FOR AGES THE ONLY, MODE OF SOWING SEED WAS BY HAND, BY WHICH THE SEED WAS USED WITH LITTLE ECONOMY, AND SCATTERED WITH BUT LITTLE PRECISION. IN THE EAST IT WAS THE CUSTOM TO PREPARE THE SOIL BY TREADING IT WITH THE FEET OF THE OX AND THE ASS. (ISAIAH, xxxii, 20; AND MATTHEW, xiii, 3) HISTORY, HOWEVER, FAILS TO TELL US WHO INVENTED THE FIRST SEEDING-MACHINE, OR EVEN WHERE IT WAS MADE, YET IT DOES TELL US THAT A RUDE KIND OF DRILL HAS BEEN USED FROM A VERY REMOTE PERIOD. THE HUSBANDMEN OF CHINA, JAPAN, ARABIA, AND THE CARNATIC, HAVE DRILLED AND DIBBLED IN THEIR SEED FROM TIME IMMEMORIAL. (QUARTERLY JOURNAL OF AGRICULTURE, VOL. I, PAGE 675.) THERE WAS INVENTED IN GERMANY, ABOUT THE YEAR 1056, A DRILL-PLOW, THE CONSTRUCTION OF WHICH IS UNKNOWN. IN ENGLAND, THE FIRST PATENT FOR A SEEDING-MACHINE WAS GRANTED TO ALEXANDER HAMILTON, NOVEMBER 27, 1623, WHICH WAS THE TWENTY-SEVENTH PATENT GRANTED UNDER THE OLD LAW. THE CONSTRUCTION OF THE MACHINE IS NOT DESCRIBED IN THE SPECIFICATION, NOR IS A PLATE FURNISHED; ACCORDINGLY WE HAVE NOTHING TO GUIDE US IN ARRIVING AT AN UNDERSTANDING OF WHAT THE MACHINE WAS. ALL WE CAN LEARN IS SET FORTH IN THE FOLLOWING WORDS, COPIED FROM THE TITLE OF THE INVENTION:

"A SPIALL PRIVILEGE GRANTED TO ALEXANDER HAMILTON, ESQRE., (FOR TWENTY-ONE YEARS), OF THE SOLE PRACTISE WITHIN ENGLAND, IRELAND, AND THE DOMONS THEREOF, OF A NEWE INVENTION, BY HIM INVENTED AND PERFECTED, AS WELL FOR THE PLOUGHINGE, AS FOR THE HARROWINGE, SOWINGE, AND SEEDINGE OF CORN AND GRAIN AT GREATER EASE AND WITH MORE PFETT THAN BY ANIE OTHER MEANS HERETOFORE USED."

ABOUT THE YEAR 1733, JETHRO TULL INVENTED A MACHINE TO SOW WHEAT AND TURNIP SEED IN DRILLS, THREE ROWS AT A TIME, AND TO TULL IS GIVEN THE CREDIT OF INVENTING THE CYLINDER WITH CAVATIES IN THE SURFACE OF THE SAME FOR FEEDING THE SEED. ABOUT THE YEAR 1790 JAMES COOKE INVENTED A MACHINE BY WHICH MANURE WAS DEPOSITED WITH THE SEED. IT IS OBSERVED THAT WHILE IN LATER ENGLISH INVENTIONS MACHINES WERE CONSTRUCTED TO PLANT SEVERAL DRILLS AT A TIME, AND ALSO TO ADJUST THE MACHINE SO THAT THE DRILLS WOULD BE A GREATER OR LESS DISTANCE APART, YET UNTIL WILLIAM GROUNDSELL OBTAINED HIS PATENT, JUNE 12, 1839, IT DOES NOT APPEAR THAT A MACHINE WAS CONSTRUCTED TO DROP THE GRAIN IN HILLS, OR AT INTERVALS, THE DISTANCES OF WHICH COULD BE REGULATED AT WILL.

IN THE CULTIVATION OF CORN AND OTHER CEREALS IN THIS COUNTRY, IN THE EARLIER TIMES, THE CONDITION OF THE NEWLY CLEARED LAND PRECLUDED THE EMPLOYMENT OF MACHINERY IN THE PLANTING AND SOWING OF SEEDS; AND HENCE CORN WAS PLANTED BY HAND, AND WHEAT AND OTHER SMALL GRAINS WERE SOWN BROAD-CAST. MACHINERY COULD NOT HAVE BEEN MADE AVAILABLE TO ANY GREAT EXTENT FOR THIS PURPOSE, IN CONSEQUENCE OF THE PRESENCE OF ROOTS AND STUMPS OF TREES OF THE PRIMITIVE FORESTS; AND IT WAS NOT UNTIL THE LANDS OF THE



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
DIVISION OF AGRICULTURAL ENGINEERING  
(EXTRACT FROM THE REPORT OF THE COMMISSIONER  
AGRICULTURE FOR 1901)

June, 1904.

Information Series No. 53.

GRAIN DRILLS AND SOWING MACHINES

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NEW ENGLAND, SOUTHERN, AND MIDDLE STATES HAD BECOME CULTIVATED, AND IMMIGRATION, EXTENDED TO THE PRAIRIES OF THE WEST, THAT A NECESSITY FOR THIS CLASS OF AGRICULTURAL MACHINERY WAS FELT. THE FIRST PATENT GRANTED FOR A CORN-PLANTER IN THIS COUNTRY WAS TO ELIAKIM SPOONER, OF VERMONT, JANUARY 25, 1799; THE FIRST FOR A COTTON-PLANTER TO CHRISTOPHER FORD, OF VIRGINIA, MAY 26, 1825. FROM 1800 TO 1828 THERE WERE BUT FEW PATENTS GRANTED FOR SEEDING-MACHINES OF ANY DESCRIPTION. AUGUST 13, 1828, A PATENT WAS GRANTED TO AUSTIN H. AND LEVI ROBBINS FOR A MACHINE FOR PLANTING DIFFERENT SEEDS. THE MACHINE IS PLACED UPON A FRAME AND WHEEL SIMILAR IN CONSTRUCTION TO THAT OF A COMMON WHEELBARROW, AND WAS PUSHED OVER THE GROUND, THE OPERATOR WALKING BEHIND. A WRITER, SPEAKING OF THIS MACHINE, IN NOVEMBER, 1828, SETS FORTH ITS VALUE AS FOLLOWS:

"THERE CAN BE NO DIFFICULTY IN THE APPLICATION OF THIS MACHINE TO THE PLANTING OF ANY KIND OF SEEDS, AND ANY NUMBER OF THEM AT A TIME, AND AT ANY REQUIRED DISTANCE, AS FAST AS A MAN CAN WALK. WHEN THE ROWS ARE SET FOUR FEET APART ONE WAY AND EIGHTEEN INCHES THE OTHER, THERE IS NO DIFFICULTY, NOR IS IT A VERY HARD DAY'S WORK, FOR A MAN TO PLANT TEN ACRES AFTER THE GROUND IS PROPERLY PREPARED TO RECEIVE THE SEED."

AUGUST 22, 1828, A PATENT WAS GRANTED TO ORSON STARR, OF RICHMOND, ONTARIO COUNTY, NEW YORK, FOR A "MACHINE FOR PLANTING GRAIN AND OTHER SEEDS." THIS MACHINE DIFFERS FROM THE ONE ABOVE MENTIONED IN SEVERAL PARTICULARS. IT HAS HANDLES AND A BEAM SIMILAR TO THE COMMON PLOW, SUPPORTED FROM THE REAR BY WHEELS; BENEATH AND ABOUT THE CENTER OF THE BEAM THERE IS A SHOVEL PLOW TO OPEN THE FURROW FOR THE RECEPTION OF THE SEED, AND TO THE REAR OF THE MACHINE IS ATTACHED AN IRON SCRAPER TO CLOSE THE FURROW AFTER THE SEED IS DROPPED. ON THE TOP OF THE BEAM IS PLACED A HOPPER IN WHICH A CYLINDER IS MADE TO REVOLVE BY SUITABLE MECHANISM. THE CYLINDER IS MADE OF SHEET IRON; THE EDGE OF IT IS PERFORATED AT SUITABLE DISTANCES TO RECEIVE PIECES OF METAL WHICH ACT AS VALVES WORKING UPON A PIN, AND FORCED OUT BY SPRINGS CONTAINED WITHIN THE WHEEL, SO AS TO PROJECT BEYOND ITS PERIPHERY, BUT CAPABLE OF BEING FORCED IN WHEN PASSING THE ENDS OF THE SLOT IN THE BOTTOM OF THE HOPPER. THESE VALVES CONTAIN THE QUANTITY OF SEED TO BE DROPPED IN EACH HILL, AND MAY BE MORE OR LESS NUMEROUS ACCORDING TO THE DISTANCE AT WHICH THEY ARE TO BE DROPPED IN THE FURROW. FOR A FULL DESCRIPTION AND REPRESENTATIONS OF THE TWO LAST-NAMED MACHINES, SEE THE FRANKLIN JOURNAL, VOL. 6, SECOND SERIES, PAGES 343 TO 348.

NUMEROUS PATENTS HAVE BEEN TAKEN OUT WITHIN THE PAST FEW YEARS FOR SEEDING MACHINES, WHICH MAY BE DIVIDED INTO THE FOLLOWING CLASSES, VIZ: 1ST. BROADCAST SEEDERS, BY WHICH THE SEED IS SOWN BROADCAST OVER THE LAND. 2D. GRAIN DRILLS, BY WHICH THE SEED IS DEPOSITED IN DRILLS. 3D. CORN PLANTERS, BY WHICH THE SEED IS, FOR THE MOST PART, PLANTED IN HILLS. 4TH. COTTON PLANTERS. 5TH. POTATO PLANTERS. NOT A FEW PERSONS HAVE ATTEMPTED TO COMBINE ALL THE ABOVE-NAMED MACHINES IN ONE, AND BESIDES ADD A PLOW, HARROW, COTTON-CHOPPER, AND CULTIVATOR. IT IS ENOUGH TO SAY THAT THE ATTEMPT HAS BEEN A FAILURE. A MACHINE CAN EASILY BE SO ARRANGED AS TO BE CHANGED FROM A GRAIN DRILL TO PLANT IN HILLS, BY DIMINISHING THE NUMBER OF CAVITIES ON THE DROPPING WHEEL; THEN, BY REMOVING THE DROPPING MECHANISM THE MACHINE MAY BE USED AS A WHEEL CULTIVATOR, A WHEEL PLOW, OR A HARROW, OR EVEN A



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LAND-ROLLER MAY BE ATTACHED; BUT TO PLANT COTTON OR POTATOES A GENERAL CHANGE IN THE WHOLE DROPPING MECHANISM WOULD BE REQUIRED. COTTON SEED CANNOT BE DROPPED WITH ACCURACY EITHER BY A SLIDE OR BY A REVOLVING CYLINDER, OWING TO THE LINT WITH WHICH THE SEED IS COVERED. IT REQUIRES A CYLINDER (REVOLVING IN THE BOTTOM OF THE HOPPER) PROVIDED WITH ARMS, SLIGHTLY CURVED IN THE DIRECTION OF WHICH THEY MOVE, SO THAT AS THE ARMS PASS THROUGH A SLOT IN THE BOTTOM OF THE HOPPER A CERTAIN QUANTITY OF THE SEED WILL BE CARRIED WITH THEM.



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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

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RUBBLE MASONRY.

THERE ARE FEW BUILDING MATERIALS MORE PLEASING IN EFFECT OR THAT LEND THEMSELVES TO A GREATER VARIATION OF EXPRESSION THAN STONE. THE FEELING IN STONE WORK IS INFLUENCED CHIEFLY BY THE SELECTION OF A KIND ADAPTED TO THE TYPE OF ARCHITECTURE AND IS ACCENTUATED BY THE SHAPE OF THE PIECES, METHOD OF FORMING THE JOINTS AND THE COLOR OF THE STONE AND MORTAR.

THE SAME STONE CAN BE DRESSED OR TOOLED IN VARIOUS WAYS SO AS TO PRODUCE ENTIRELY DIFFERENT EFFECTS IN THE INDIVIDUAL STONES AND IN THE WALL AS A WHOLE. GENERALLY THE HEAVY AND COARSE GRAINED ROCKS, SUCH AS GRANITE, ARE FINISHED WITH ROUGH OR COARSE SURFACES WHILE THE FINER GRAINED AND SOFTER ONES, LIKE SANDSTONE OR MARBLE, ARE BEST FINISHED SMOOTH. CLASSIC DESIGNS, OR THOSE REQUIRING REFINEMENT OF DETAIL, SHOULD BE EXECUTED IN SMOOTH SQUARED STONES LAID WITH THIN FINE JOINTS GIVING A CHASTE EFFECT WHILE RUSTIC OR MASSIVE STRUCTURES PERMIT OF HEAVY, ROUGH AND IRREGULARLY LAID STONES, SUGGESTING STRENGTH AND BOLDNESS.

SKILLFUL USE OF TOOLS AND MACHINES ARE REQUIRED TO PRODUCE THE FINISH SEEN ON STONES USED IN MANY CITY BUILDINGS AND MONUMENTS AND AS THE OBJECT OF THESE NOTES IS TO OUTLINE THE PROPER METHOD OF CONSTRUCTING SIMPLE STRUCTURES FROM LOCAL MATERIALS THE DISCUSSION IS LIMITED TO RUBBLE STONE WORK.

RUBBLE IS THE TERM GENERALLY APPLIED TO STONE WORK OF THE SIMPLEST KIND, THAT IS, LITTLE OR NO TOOL WORK IS DONE ON THE STONES OTHER THAN TO BREAK THEM UP WITH A HAMMER AND ROUGHLY DRESS THEM. WHEN SUCH ROUGH STONES ARE BUILT IN COURSES WITH LEVEL BEDS THE WORK IS CALLED COURSED-RUBBLE, FIGURE 1; WHEN THE STONES ARE OF VARYING SIZE AND SHAPE LAID WITHOUT REGARD TO THE DIRECTION OF THE JOINTS THE WORK IS KNOWN AS RANDOM RUBBLE. FIGURE 2. SOMETIMES THE STONES ARE ROUGHLY SQUARED AND FACED AND LAID ON LEVEL BEDS TO FORM MORE OR LESS BROKEN COURSES; SUCH WORK IS KNOWN AS DRESSED-RUBBLE. FIGURE 3.

FREQUENTLY LOCAL STONE THAT IS NOT MARKETABLE CAN BE USED IN FARM DWELLINGS AND OUTBUILDINGS WHICH WILL HARMONIZE WITH THE LANDSCAPE NO MATTER HOW CRUDELY THE WORK MAY BE DONE. SUCH STONE WORK IMPROVES IN APPEARANCE WITH AGE AND IS ESPECIALLY BEAUTIFUL WHEN PARTLY COVERED WITH VINES OR LICHENS AND MOSS.

IN SELECTING LOCAL STONES THE FIRST QUALITY TO CONSIDER IS DURABILITY. THIS QUALITY MAY BE OBSERVED BY EXAMINING OLD NATIVE STONE STRUCTURES, SUCH AS MONUMENTS, TOMBSTONES, PAVINGS OR PIERS. A DURABLE STONE WILL RETAIN FOR A LONG TIME TOOL MARKS MADE UPON IT AND ITS EDGES AND CORNERS WILL REMAIN SHARP AND TRUE.



UNITED STATES DEPARTMENT OF AGRICULTURE  
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STONE MASONRY

There are few building materials more pleasing in effect or that lend themselves to a greater variation of expression than stone. The feeling in stone work is introduced chiefly by the selection of a kind adapted to the type of architecture and is accentuated by the shape of the pieces, method of forming the joints and the color of the stone and mortar.

The same stone can be dressed or tooled in various ways so as to produce entirely different effects in the individual stones and in the wall as a whole. Generally the heavy and coarse grained rocks, such as granite, are finished with rough or coarse surfaces while the finer grained and softer ones, like limestone or marble, are left finished smooth. Classic designs, or those requiring refinement of detail, should be executed in smooth squared stone laid with thin joints giving a classic effect while rustic or massive structures permit of heavy, rough and irregular laid stones, suggesting strength and solidity.

Skilful use of tools and machines are required to produce the finish seen on stones used in many city buildings and monuments and as the object of these notes is to supply the proper method of construction simple structures from local materials the discussion is limited to rustic stone work.

Rubble is the term generally applied to stone work of the simplest kind, that is, little or no work is done on the stones other than to break them up with a hammer and roughly dress them. When such rough stones are built in courses with level beds the work is called coursed rubble. Figure 1 shows the stones are of varying size and shape laid with out regard to the direction of the joints the work is known as random rubble. Figure 2, sometimes the stones are roughly squared and faced and laid on level beds to form work or less broken courses. Such work is known as dressed rubble. Figure 3.

Frequently local stone that is not marketable can be used in farm buildings and outbuildings which will harmonize with the landscape no better than roughly the work may be done. Such stone work improves in appearance with age and is especially beautiful when partly covered with vines or climbing moss.

In selecting local stones the first quality to consider is durability. This quality may be ascertained by examining old water stone structures, such as monuments, tombstones, fences or paths. A durable stone will retain for a long time the sharp edges and corners and will remain sharp and true.



IN MANY SECTIONS OF THE COUNTRY ARE DEPOSITS OF STRATIFIED ROCK, SUCH AS LIMESTONE, FROM WHICH PIECES CAN BE EASILY OBTAINED BY USE OF HAMMERS AND WEDGES. IN SOME CASES BLASTING MAY BE ECONOMICAL. FREQUENTLY BOWLERS OR FIELD STONE THAT ARE SUITABLE FOR SMALL STRUCTURES MAY BE FOUND IN FIELDS OR ALONG STREAMS. SLAB-LIKE SHAPES ARE EASIER TO HANDLE IN A WALL BUT ROUND BOWLERS CAN BE SPLIT SO AS TO FORM GOOD BED JOINTS. COBBLE OR SMALL ROUND STONES ARE BEST USED AS A VENEER OR FACING OF A BEARING WALL MADE OF SUBSTANTIAL MASONRY.

STONE, WHEN FIRST TAKEN FROM A QUARRY CONTAINS SAP. AFTER EXPOSURE FOR SOME TIME THIS SAP CRYSTALLIZES AND THE STONE BECOMES HARDER AND IS THUS BETTER ABLE TO RESIST THE DESTRUCTIVE ACTION OF THE ELEMENTS, STONES SHOULD BE LAID SO AS TO BEAR ON THEIR SPLITTING SURFACE (BEDJOINT) AS IN THIS POSITION THE FROST WILL NOT PENETRATE THE STRATIFIED LAYERS AND SPLIT THEM OFF.

TOO MUCH CARE CANNOT BE TAKEN TO SECURE A GOOD STABLE FOUNDATION. THE FOOTINGS SHOULD BE CARRIED DOWN BELOW THE FROST LINE AND TO SOLID GROUND. THE BEST FOOTING IS FORMED BY USING LARGE FLAT STONES TAKING CARE THAT THEY REST ON A FIRM BED AND DO NOT ROCK. TO INSURE AN EVEN BEARING ON THE SOIL IT IS WELL TO SET THE FIRST COURSE OF STONES IN A THICK BED OF CEMENT MORTAR AND WORK THEM AROUND WITH BARS UNTIL SOLIDLY BEDDED. THE JOINTS SHOULD THEN BE FILLED WITH GROUT OR MORTAR THINNED WITH WATER SO THAT IT WILL RUN INTO ALL VOIDS. WHEN THE FOOTING CONSISTS OF SINGLE STONES EXTENDING ACROSS THE FULL WIDTH OF THE TRENCH, THE THICKNESS OF THE STONES SHOULD BE ABOUT ONE QUARTER THEIR WIDTH. WHEN NECESSARY TO USE TWO STONES TO SPAN THE WIDTH THE JOINT SHOULD BE MADE UNDER THE CENTER OF THE WALL AND THE SECOND COURSE SHOULD BE A SINGLE STONE PLACED ON TOP AS SHOWN IN FIGURE 4 (A). THE FOOTING SHOULD NOT PROJECT TOO FAR BEYOND THE WALL BECAUSE THE STONES ARE LIABLE TO CRACK. THE DOTTED LINE A B FIGURE 4 (B) INDICATES THE APPROXIMATE LIMIT OF PROJECTION.

FOR LIGHT DWELLINGS, TWO STORIES IN HEIGHT AND BUILT ON GOOD SOIL, THE FOOTING CAN BE MADE OF IRREGULAR STONES LAID AS SHOWN IN FIGURE 5. SPACES BETWEEN THE STONES SHOULD BE FILLED WITH CEMENT AND SMALL STONES.

NO WALL OF RUBBLE SHOULD BE LESS THAN 18 INCHES THICK AND IF THE STRUCTURE IS TALL OR TO BE SUBJECTED TO HEAVY WEIGHTS A GREATER THICKNESS IS REQUIRED.

ASIDE FROM THE QUALITY OF THE STONE AND MORTAR THE STRENGTH OF A RUBBLE WALL DEPENDS UPON THE MANNER IN WHICH IT IS BONDED OR TIED TOGETHER BY LAPPING THE STONES OVER EACH OTHER. STONES WHICH ARE LONG ENOUGH TO EXTEND ENTIRELY THROUGH THE WALL ARE CALLED BOND STONES. THESE SHOULD OCCUR EVERY 4 TO 5 FEET IN EACH COURSE OR THERE SHOULD BE ONE IN AT LEAST EVERY 10 SQUARE FEET OF WALL SURFACE. LONG STONES SHOULD BE USED IN THE ANGLES OF A WALL AND SHOULD BE LAID ALTERNATELY AS HEADERS AND STRETCHERS FORMING QUOINS, FIGURE 6. THE LARGEST AND BEST STONES SHOULD BE RESERVED FOR THE CORNERS AS THESE ARE LIABLE TO BE THE WEAKEST PARTS OF THE WALL.



IN MANY SECTIONS OF THE COUNTRY AND DEPOSITS OF STRATIFIED ROCK, SUCH AS LIMESTONE, FROM WHICH ROCKS CAN BE EASILY OBTAINED BY USE OF HAMMERS AND WEDGES. IN SOME CASES EXCAVATING MAY BE NECESSARY. FREQUENTLY SOMEWHERE ON FIELD STONE THAT ARE SUITABLE FOR SMALL STRUCTURES MAY BE FOUND IN FIELD OR ALONG STAGERS. CLASSICAL CHURCH AND EASIER TO HANDLE IN A WALL BUT ROUND BOUTHERN CAN BE SPLIT AS TO FORM GOOD BED JOINTS. COURSE OF SMALL ROUND STONES ARE BEST USED AS A VENEER OR FACING OF A BEARING WALL MADE OF SUBSTANTIAL MASSIVE.

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FOR MUCH GARDEN MASONRY BE TAKEN TO BECOME A GOOD STABLE FOUNDATION. THE FOOTINGS SHOULD BE BARRIED DOWN BELOW THE FROST LINE AND TO BE LAIN ON SOUND. THE BEST FOOTING IS FORMED BY USING LARGE FLAT STONES TAKING CARE THAT THEY REST ON A FIRM SOIL AND DO NOT ROCK. IT SHOULD BE BARRIED ON THE SOIL IT IS WELL TO SET THE FIRST COURSE OF STONES IN A THICK BED OF MORTAR AND WORK THEM AROUND WITH BRASS WIRE SPOOLS. THE JOINTS SHOULD THEN BE FILLED WITH GROUT OR MORTAR THICKLY BEDDED. THE JOINTS SHOULD THEN BE FILLED WITH GROUT OR MORTAR THICKLY BEDDED. WITH WATER SO THAT IT WILL RUN INTO ALL JOINTS. WHEN THE FOOTING CONSISTS OF MIXED STONES KEYHOLE ACROSS THE FULL WIDTH OF THE TIERED. THE THICKNESS OF THE STONE SHOULD BE ABOUT ONE QUARTER THEIR WIDTH. WHEN MASONRY IS TO BE LAIN TO BEAR THE WEIGHT OF THE ROOF OR OF A WALL OVER THE CENTER OF THE WALL AND THE SECOND COURSE SHOULD BE A SINGLE STONE FLAT ON TOP AS SHOWN IN FIGURE 4 (A). THE FOOTING SHOULD NOT BE LAIN TOO FAR FROM THE WALL BECAUSE THE MASONRY CAN SLIDE TO GRADE. THE OUTSIDE LINE OF A 8 FIGURE 4 (B) INDICATES THE APPROXIMATE LIMIT OF PROTECTION.

FOR LIGHT DWELLINGS, TWO STORIES IN HEIGHT AND BUILT ON GOOD SOIL, THE FOOTING CAN BE MADE OF THE SAME STONE LAIN AS SHOWN IN FIGURE 4. SPACES BETWEEN THE STONES SHOULD BE FILLED WITH GROUT AND SMALL STONES.

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ASIDE FROM THE QUALITY OF THE STONE AND MORTAR THE STRENGTH OF A RUBBLE WALL DEPENDS UPON THE MANNER IN WHICH IT IS BUILT OR TIED TOGETHER BY LAPPING THE STONES OVER EACH OTHER. STONES WHICH ARE LONG ENOUGH TO EXTEND ENTIRELY THROUGH THE WALL ARE CALLED LONG STONES. THESE SHOULD OCCUR EVERY 4 TO 5 FEET IN EACH COURSE OR THERE SHOULD BE ONE IN AT LEAST EVERY 10 SQUARE FEET OF WALL SURFACE. LONG STONES SHOULD BE USED IN THE ANGLES OF A WALL AND SHOULD BE LAIN ALTERNATELY AS HEADERS AND STRETCHERS FORMING CORNERS. FIGURE 5. THE LARGEST AND BEST STONES SHOULD BE RESERVED FOR THE CORNERS AND THERE ARE PLACES TO BE THE WEAKEST PARTS OF THE WALL.



IN BUILDING A WALL THE SUCCESSIVE COURSES SHOULD BREAK JOINTS, THAT IS, THE VERTICAL JOINTS SHOULD NOT OCCUR OVER THOSE OF THE PRECEDING COURSE. THE WALL SHOULD BE ROUGHLY LEVELED OFF ABOUT EVERY TWO FEET IN HEIGHT BOTH LONGITUDINALLY AND HORIZONTALLY AND THE HORIZONTAL JOINTS SHOULD BE KEPT AS NEAR LEVEL AS POSSIBLE. CONTINUOUS HORIZONTAL JOINTS SHOULD BE AVOIDED IN RUBBLE WORK. A STONE MAY BE BROUGHT TO A DESIRE LEVEL BY VARYING THE THICKNESS OF THE MORTAR JOINT. MUCH MORTAR CAN BE SAVED BY THE USE OF SPALLS OR SMALL PIECES OF STONE FOR CHINKING THE SPACES BETWEEN LARGE IRREGULAR STONES.

WHILE A GOOD WALL FACE IS DESIRABLE STRENGTH SHOULD NOT BE SACRIFICED AS IS FREQUENTLY THE CASE WHEN THIN STONES ARE SET ON EDGE AND THEN BACKED; ALL STONES SHOULD EXTEND 6 OR MORE INCHES INTO THE WALL. MANY MASONS ARE APT TO BUILD THE TWO FACES OF A WALL WITH LONG NARROW STONES AND FILL IN BETWEEN WITH DRY STONES, THROWING A LITTLE MORTAR ON TOP. FIGURE 7. A WALL OF THIS KIND IS WEAK AND SHOULD NOT BE PERMITTED.

THE STONES JUST BELOW AN OPENING SHOULD BE LAID SO AS TO SPREAD THE WEIGHT CARRIED BY THE WALL ON EITHER SIDE OF IT AS SHOWN BY THE STONES A B C FIGURE 8. IF THE WALL IS TO CARRY ANY GREAT WEIGHT IT IS BEST NOT TO BUILD THE SILLS INTO THE JAMBS OF THE OPENING BUT TO MAKE THEIR LENGTH JUST EQUAL TO THE WIDTH OF THE OPENING. THESE ARE CALLED "SLIP-SILLS" AND ALTHOUGH THEY ARE LESS DESIRABLE FROM THE STANDPOINT OF APPEARANCE THERE IS NO DANGER OF THEIR BEING BROKEN BY UNEQUAL SETTLEMENT OF THE WALL. THE TOP OF ALL SILLS SHOULD BE SLOPED OR PITCHED TO SHED WATER AND THERE SHOULD BE A DRIP OR GROOVE CUT ON THE UNDER SIDE TO PREVENT WATER ENTERING THE JOINT UNDER THE SILL. LUG SILLS, THAT IS THOSE BUILT INTO THE WALL, SHOULD NOT EXTEND INTO THE JAMBS MORE THAN 4 INCHES WHILE  $2\frac{1}{2}$  INCHES IS COMMON PRACTICE. THEY SHOULD BE SET WITHOUT MORTAR EXCEPT AT THE ENDS LEAVING AN OPEN JOINT OF  $\frac{1}{2}$  INCH OR MORE FOR THE WIDTH OF THE OPENING; AFTER SETTLEMENT IN THE JOINTS OF THE WALL HAS CEASED THE OPEN JOINT MAY BE POINTED UP.

A SINGLE LARGE STONE OVER AN OPENING IS CALLED A LINTEL AND ACTS AS A BEAM. IF THE OPENING IS WIDE THE STONES ABOVE THE LINTEL SHOULD BE ARRANGED SO AS TO RELIEVE IT OF SOME OF THE WEIGHT. FIGURE 9. STEEL ANGLES MAY BE USED TO SUPPORT THE STONEMWORK OVER AN OPENING IF THE SPAN IS LESS THAN 6 FEET, OR "I" BEAMS IF THE SPAN IS GREATER.

SEMI-CIRCULAR, SEGMENTAL OR FLAT ARCHES MAY BE FORMED OVER OPENINGS TO SUPPORT THE WALL ABOVE AS SHOWN IN FIGURE 10 A B & C. FLAT ARCHES MAY BE DESIRABLE BUT TO BE SELF SUPPORTING THEY MUST BE OF AMPLE HEIGHT AND SHOULD NOT BE USED FOR SPANS GREATER THAN 4 FEET. FLOOR BEAMS SHOULD NEVER BE SUPPORTED ON STONE LINTELS OR ARCHES.

EVERY ARCH SHOULD BE BUILT ON A WOODEN CENTER OR FORM MADE TO EXACTLY FIT THE CURVE OF THE ARCH AND CAREFULLY SET IN PLACE. THE CENTER SHOULD HAVE AMPLE STRENGTH TO SUPPORT THE WEIGHT OF THE ARCH AND MUCH OF THE WALL ABOVE, AS IT IS UNDESIRABLE TO PUT ANY WEIGHT ON THE ARCH UNTIL THE MORTAR IN THE JOINTS HAS BECOME HARD. A CENTER IS USUALLY MADE WITH TWO RIBS CUT OUT OF PLANK AND SECURELY SPIKED TOGETHER, AND



IN BUILDING A WALL THE SUCCESSIVE COURSES SHOULD BE BUILT JOINTS, THAT IS, THE VERTICAL JOINTS SHOULD NOT OCCUR OVER THOSE OF THE PRECEDING COURSE. THE WALL SHOULD BE ROUGHLY LEVELLED OUT ABOUT EVERY TWO FEET IN HEIGHT BOTH LONGITUDINALLY AND HORIZONTALLY AND THE HORIZONTAL JOINTS SHOULD BE KEPT AS NEAR LEVEL AS POSSIBLE. CONTINUOUS HORIZONTAL JOINTS SHOULD BE AVOIDED IN RUBBLE WORK. A STONE MAY BE BROUGHT TO A DESIRE LEVEL BY VARYING THE THICKNESS OF THE MORTAR JOINT. MUCH MORTAR CAN BE SAVED BY THE USE OF SMALL OR SMALL PIECES OF STONE FOR CHIMING THE SPACES BETWEEN LARGE IRREGULAR STONES.

WHILE A GOOD WALL FACE IS DESIRABLE STRENGTH SHOULD NOT BE SACRIFICED AS IS FREQUENTLY THE CASE WHEN THIN STONES ARE SET ON EDGE AND THEN BACKED. ALL STONES SHOULD EXTEND 6 OR MORE INCHES INTO THE WALL. MANY MASONRY ARE apt TO BUILD THE TWO FACES OF A WALL WITH LONG NARROW STONES AND FILL IN BETWEEN WITH DRY STONES, THROWING A LITTLE MORTAR ON TOP. FIGURE 7. A WALL OF THIS KIND IS WEAK AND SHOULD NOT BE PERMITTED.

THE STONES JUST BELOW AN OPENING SHOULD BE LAID AS TO SPREAD THE WEIGHT CARRIED BY THE WALL ON EITHER SIDE OF IT AS SHOWN BY THE STONES A & B FIGURE 8. IF THE WALL IS TO CARRY ANY GREAT WEIGHT IT IS BEST NOT TO BUILD THE BILLS INTO THE JAMBS OF THE OPENING BUT TO MAKE THEIR LENGTH JUST EQUAL TO THE WIDTH OF THE OPENING. THESE ARE CALLED "PIERS" AND ALTHOUGH THEY ARE LESS DESIRABLE THAN THE STANDING OF APPROPRIATE THERE IS NO DANGER OF THEIR BEING BROKEN BY UNEQUAL SETTLEMENT OF THE WALL. THE TOP OF ALL BILLS SHOULD BE SLOPED OR PITCHED TO SHED WATER AND THERE SHOULD BE A DRAIN OR GROOVE CUT ON THE UNDER SIDE TO PREVENT WATER ENTERING THE JOINT UNDER THE BILL. LUG STILES, THAT IS THOSE BUILT INTO THE WALL, SHOULD NOT EXTEND INTO THE JAMBS MORE THAN 4 INCHES WHILE 24 INCHES IS COMMON PRACTICE. THEY SHOULD BE SET WITHOUT MORTAR EXCEPT AT THE END LEAVING AN OPEN JOINT OF 1/2 INCH OR MORE FOR THE WATER OR THE OPENING. AFTER SETTLEMENT IN THE JOINTS OF THE WALL HAS CEASED THE OPEN JOINT MAY BE POINTED UP.

A SINGLE LARGE STONE OVER AN OPENING IS CALLED A LINTEL AND ACTS AS A BEAM. IF THE OPENING IS WIDE THE STONE ABOVE THE LINTEL SHOULD BE ARRANGED SO AS TO RELIEVE IT OF SOME OF THE WEIGHT. FIGURE 9. STEEL ANGLES MAY BE USED TO SUPPORT THE STONEWORK OVER AN OPENING IF THE SPAN IS LESS THAN 6 FEET, OR 8" BEAMS IF THE SPAN IS GREATER.

SEMICIRCULAR, SEGMENTAL OR FLAT ARCHES MAY BE FORMED OVER OPENINGS TO SUPPORT THE WALL ABOVE AS SHOWN IN FIGURE 10 A & C. FLAT ARCHES MAY BE DESIRABLE BUT TO BE SELF SUPPORTING THEY MUST BE OF ANGLE HEIGHT AND SHOULD NOT BE USED FOR SPANS GREATER THAN 4 FEET. FLOOR BEAMS SHOULD NEVER BE SUPPORTED ON STONE LINTELS OR ARCHES.

EVERY ARCH SHOULD BE BUILT ON A WOODEN CENTER OR FORM MADE TO EXACTLY FIT THE CURVE OF THE ARCH AND CAREFULLY SET IN PLACE. THE CENTER SHOULD HAVE ANGLE STRENGTH TO SUPPORT THE WEIGHT OF THE ARCH AND MUCH OF THE WALL ABOVE, AS IT IS UNDESIRABLE TO PUT ANY WEIGHT ON THE ARCH UNTIL THE MORTAR IN THE JOINTS HAS BECOME HARD. A CENTER IS USUALLY MADE WITH TWO RIBS CUT OUT OF PLANK AND SECURELY SPIKED TOGETHER, AND



THE BEARING SURFACE FORMED OF CROSS PIECES ABOUT 1 BY 2 INCHES IN SIZE NAILED TO THE TOP OF THE RIBS, AS SHOWN IN FIGURE 11. THE RIBS FORMING THE SUPPORTS FOR THE CROSS PIECES SHOULD BE PLACED UNDER EACH EDGE OF THE ARCH, AND IF THE DEPTH OF THE ARCH (THICKNESS OF WALL) EXCEEDS 12 INCHES THREE RIBS SHOULD BE USED. THE CENTER SHOULD BE SUPPORTED ON WOODEN POSTS RESTING ON BLOCKS SET ON THE SILL OR SOME SUFFICIENT SUPPORT BELOW. IT SHOULD NOT BE REMOVED UNTIL THE MORTAR IN THE ARCH JOINTS HAS HAD AMPLE TIME TO SET.

PORTLAND CEMENT MORTAR SHOULD ALWAYS BE USED FOR FOOTINGS, RUBBLE WORK BELOW GROUND, PIERS, COLUMNS AND IN DAMP PLACES. FREQUENTLY THE MASONRY ABOVE GROUND IS LAID IN LIME MORTAR WHICH HAS STRENGTH ENOUGH FOR SMALL BUILDINGS NOT CARRYING HEAVY LOADS BUT CEMENT MORTAR IS PREFERABLE. LIME MORTAR SHOULD NEVER BE USED WHERE IT WILL BE SUBJECTED TO DAMPNESS.

A MORTAR COMPOSED OF 1 PART PORTLAND CEMENT AND 3 PARTS SAND SHOULD RESIST A CRUSHING LOAD, AFTER THREE MONTHS, OF 40 TONS PER SQUARE FOOT AND AT THE END OF A YEAR 65 TONS. A SIMILARLY MIXED LIME MORTAR CAN RESIST BUT 8.6 TONS AFTER 3 MONTHS AND 15 TONS AT THE END OF A YEAR.

SAND IS USED IN MORTAR TO PREVENT EXCESSIVE SHRINKAGE AND TO REDUCE THE COST OF THE LIME OR CEMENT. CEMENT MORTAR FOR GENERAL WORK SHOULD BE MIXED IN THE PROPORTION OF 1 PART CEMENT TO 3 PARTS SAND MEASURED BY VOLUME. A LITTLE LIME PUTTY MAY BE ADDED TO MAKE THE MORTAR MORE PLASTIC AND EASIER TO HANDLE. SOME AUTHORITIES CLAIM THAT A MORTAR COMPOSED OF 1 PART CEMENT, 6 PARTS SAND AND 1 PART LIME PUTTY IS AS GOOD AS A MORTAR MADE FROM 1 PART CEMENT AND 3 PARTS SAND, BUT THIS IS NOT RECOMMENDED FOR FIRST CLASS WORK. LIME MORTAR IS USUALLY MIXED IN THE PROPORTIONS OF 1 PART LIME PUTTY TO 3 PARTS SAND.

PIT OR BANK SAND IS GENERALLY CONSIDERED BEST FOR MORTAR ALTHOUGH SOME RIVER BED SAND IS EXCELLENT. SEA SAND CONTAINS ALKALINE SALTS WHICH ARE OBJECTIONABLE. THE SAND SHOULD BE FREE FROM DUST, LOAM, LARGE STONES AND VEGETABLE MATTER. FOR ROUGH STONE WORK A COMBINATION OF COARSE AND FINE SANDS MAKES THE STRONGEST MORTAR.

ONE BARREL OF 230 POUNDS OF LUMP LIME (3 BUSHELS) MAKES ABOUT 2-3/4 BARRELS OF PASTE WHICH IF MIXED WITH 1 CUBIC YARD OF SAND WILL MAKE 1 CUBIC YARD OF 1:3 LIME MORTAR. THIS IS SUFFICIENT TO LAY 3 PERCHES OR 70 TO 80 CU. FT. OF RUBBLE MASONRY. A MIXTURE OF 9.6 BAGS OF CEMENT AND 28.8 CU. FT. SAND MAKE 1 CU. YD. OF 1:3 CEMENT MORTAR.

ALL STONES SHOULD BE WELL WETTED BEFORE BEING LAID IN THE WALL. BEFORE THE MORTAR IN THE JOINTS OF THE FACE HAS SET TOO HARD IT SHOULD BE RAKED OUT ABOUT 3/4 OF AN INCH TO ALLOW FOR POINTING UP AFTER THE WALL IS COMPLETED.

POINTING IS THE FILLING OF THE RAKED OUT FACE JOINTS WITH A RICH STRONG MORTAR. THE JOINT SHOULD BE THOROUGHLY WETTED JUST BEFORE THE MORTAR IS APPLIED WITH A SMALL TROWEL MADE FOR THE PURPOSE. THE JOINT MAY BE FLAT WITH A SLIGHT OUTWARD SLOPE TO SHED WATER OR SHAPED BY RUB-



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PORTLAND CEMENT MORTAR SHOULD ALWAYS BE USED FOR FOOTINGS, BASES  
AND WORK BELOW GRADE, PILES, BELLINGS AND IN OTHER PLACES. PRESENTLY  
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(THE BARREL OF 200 POUNDS OR LUMP LIME (3 BUSHELS) MAKES ABOUT  
5 3/4 BARRELS OF PASTE WHICH IS MIXED WITH 1 CUBIC YARD OF SAND WILL  
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FOOTING OR 70 TO 80 CU. FT. OF RUBBLE MASONRY. A MIXTURE OF 8.5 PARTS  
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ING WITH A TOOL CALLED A JOINTER WHICH IS MADE WITH HOLLOW AND CONCAVE EDGES TO GIVE RAISED OR CONCAVE SHAPE TO THE JOINT. THE CONCAVE AND FLAT JOINTS ARE THE MOST DURABLE.

MORTAR FOR POINTING UP IS USUALLY MADE OF 1 PART PORTLAND CEMENT AND 1 PART FINE SAND MIXED TO A MEALY CONSISTENCY. IF COLORED JOINTS ARE DESIRED THE MORTAR MAY BE MIXED WITH THE FOLLOWING COLORING MATERIALS: TO EACH 100 POUNDS OF CEMENT ADD: FOR BLACK, 2 POUNDS EXCELSIOR CARBON BLACK; - BROWN, 6 POUNDS ROASTED IRON OXIDE; - GRAY,  $\frac{1}{2}$  POUND LAMPBLACK; - RED, 6 TO 9 POUNDS RAW IRON OXIDE; - BRIGHT RED, 6 POUNDS POMPEIIAN RED; - YELLOW OR BUFF, 6-9 POUNDS YELLOW OCHRE. FOR WHITE USE WHITE PORTLAND CEMENT AND MARBLE DUST OR WHITE SAND. WHITE CEMENT IS MORE EXPENSIVE AND NOT SO STRONG AS PORTLAND CEMENT.

THE AMOUNT OF RUBBLE THAT CAN BE LAID IN A DAY DEPENDS UPON MANY VARIABLE FACTORS BUT UNDER AVERAGE CONDITIONS A MASON AND HELPER SHOULD PLACE FROM 10 TO 12 CU. FT. OF WALL PER HOUR.

#### USE OF COBBLE STONES.

WHEN THE STONES ARE LARGE THEY CAN BE LAID AS RUBBLE, SPLITTING STONES OCCASIONALLY TO SECURE A BOND.

SMALL STONES, SHOULD BE LAID UP IN A SORT OF FORM. GUIDES MAY BE SET UP FOR THE CORNERS AND LOOSE BOARDS PLACED IN BETWEEN AND MOVED UP AS THE WORK PROCEEDS. THE LARGER STONES SHOULD BE USED IN THE LOWER PART OF THE WORK. THE FORMS ARE USED PARTLY TO KEEP THE WORK TRUE AND PARTLY TO KEEP THE STONES IN PLACE UNTIL THE MORTAR SETS. THE LABOR INVOLVED IN RAKING OUT JOINTS AND IN CLEANING THE FACE OF THE STONES OF SURPLUS MORTAR MAY BE GREATLY LESSENED AND A CONSIDERABLE SAVING OF MORTAR MAY BE EFFECTED BY USING A FAIRLY TIGHT FORM TWO OR THREE FEET HIGH AND PLACING DAMP SAND IN FRONT OF EACH STONE AS IT IS LAID. THE SAND WILL HOLD THE MORTAR BACK FROM THE FACE AND WILL FALL OUT WHEN THE FORM IS REMOVED LEAVING THE WORK READY FOR POINTING. THE SAND MAY BE KEPT FROM RUNNING OUT AT THE BOTTOM OF THE FORM BY A STUFFING OF BUILDING PAPER OR OLD SACKING.

COBBLE STONE WORK OFTEN IS BATTERED, THAT IS, SLOPED IN A LITTLE FROM THE BASE TO THE TOP. NO ATTEMPT IS MADE TO LAY THE STONE IN COURSES BUT IT IS WELL TO PLACE A SMALL STONE NEXT TO A LARGE ONE. CARE MUST BE TAKEN TO BOND THE STONES WELL AND ALL STONES SHOULD LIE ON THEIR NATURAL BED; THERE SHOULD BE HEADERS, STRETCHERS AND BOND STONES. THE CORNER STONES SHOULD BE LARGE AND LONG. ONLY PORTLAND CEMENT MORTAR, 1:3, SHOULD BE USED IN LAYING UP THE WALL THE JOINTS BEING RAKED AND POINTED WITH A RICH MORTAR AS IN RUBBLE. THE TOP OF WALLS, PIERS OR CHIMNEYS SHOULD BE CAPPED WITH CONCRETE.

#### BOOKS DEALING WITH THE SUBJECT OF MASONRY:

BUILDING CONSTRUCTION AND SUPERINTENDENCE (PART I MASONRY WORK)  
F. E. KIDDER; THE WM. T. COMSTOCK CO., NEW YORK.

HANDBOOK OF BUILDING CONSTRUCTION, HOOL & JOHNSON, MCGRAW-HILL  
BOOK CO., NEW YORK.

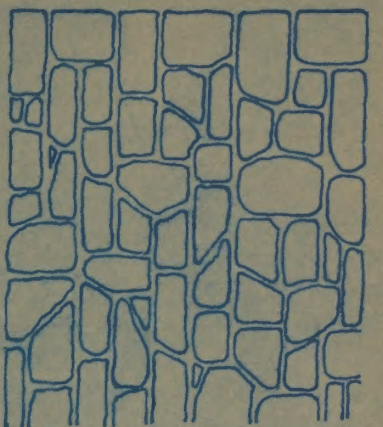
MATERIALS & WORKMANSHIP IN CONSTRUCTION; INSPECTOR'S POCKETBOOK,  
A. T. BYRNE; JOHN WILEY SONS, NEW YORK.

CIVIL ENGINEER'S POCKET-BOOK, J. C. TRAUTWINE, JOHN WILEY SONS,  
NEW YORK.

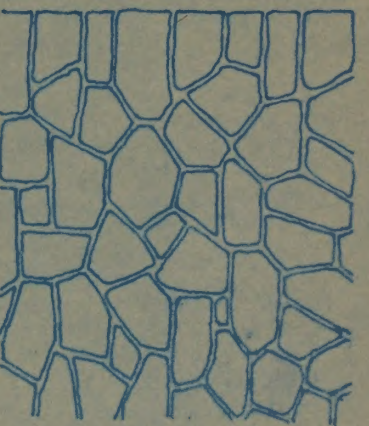




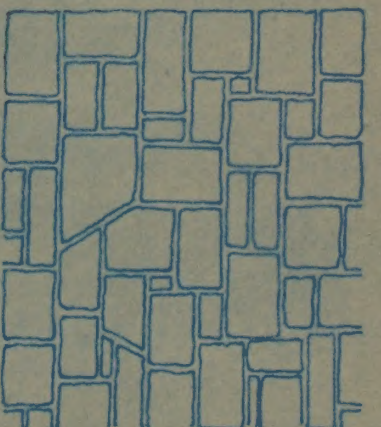




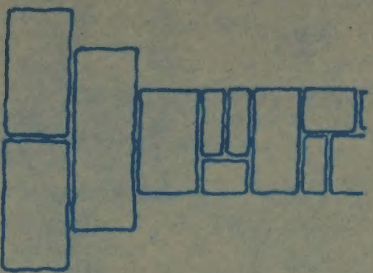
Coursed Rubble  
Fig. 1.



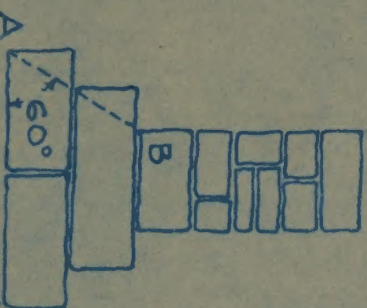
Random Rubble  
Fig. 2.



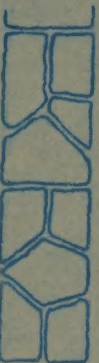
Dressed Rubble  
Fig. 3.



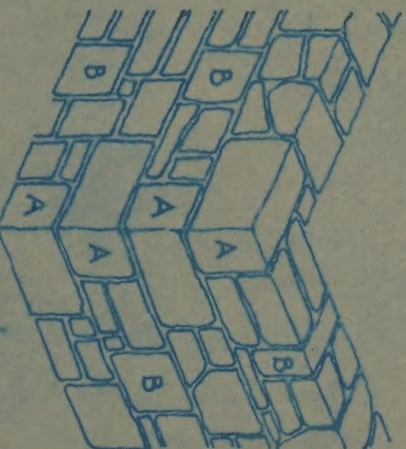
Footing  
Fig. 4. A



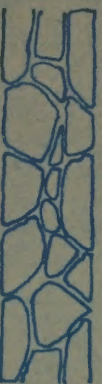
Footing Projection  
Fig. 4. B



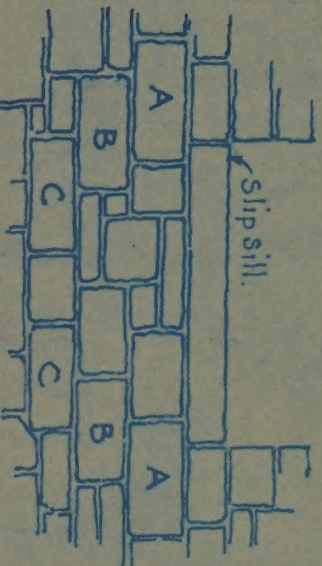
Footing for Light  
Buildings  
Fig. 5.



Angle of Wall  
(A-Quoins, B-Bond Stones)  
Fig. 6.



Two Face Wall  
Bad Construction  
Fig. 7.



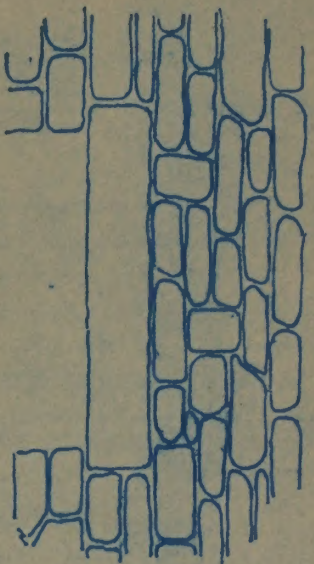
Arrangement of Stones  
under Sill to Distribute Weight  
Fig. 8.

|                                |         |                     |            |
|--------------------------------|---------|---------------------|------------|
| U.S. DEPARTMENT OF AGRICULTURE |         |                     |            |
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| DIVISION OF                    |         |                     |            |
| AGRICULTURAL ENGINEERING       |         |                     |            |
| RUBBLE MASONRY                 |         |                     |            |
| Scale                          | CHECKED | SHEET 1 OF 2 SHEETS |            |
| Drawn by N.B.                  |         |                     |            |
| Traced by N.B.                 |         |                     |            |
| Approved                       |         | SUBJ.               | SERIAL NO. |
|                                |         | 607                 | 1876       |

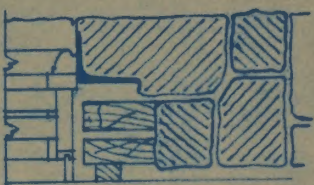




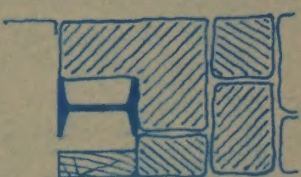




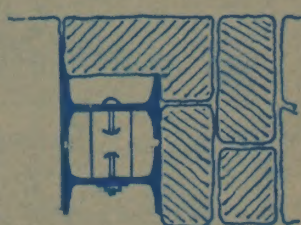
Lintel  
Fig. 9.



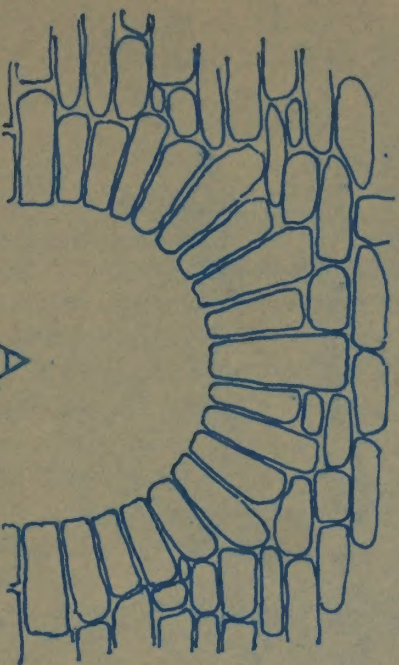
Angle Iron  
Supporting Lintel



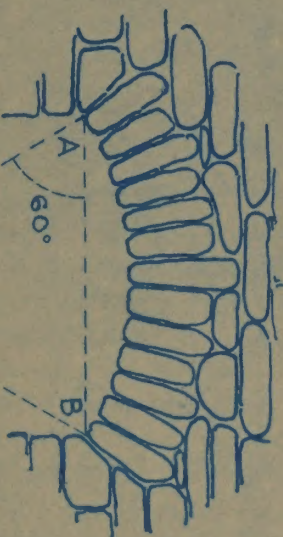
I-Beam  
Supporting Lintel



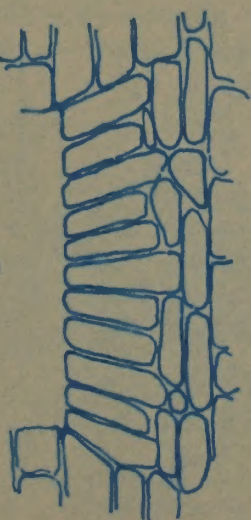
I-Beams used for  
Thick Walls and  
Wide Openings



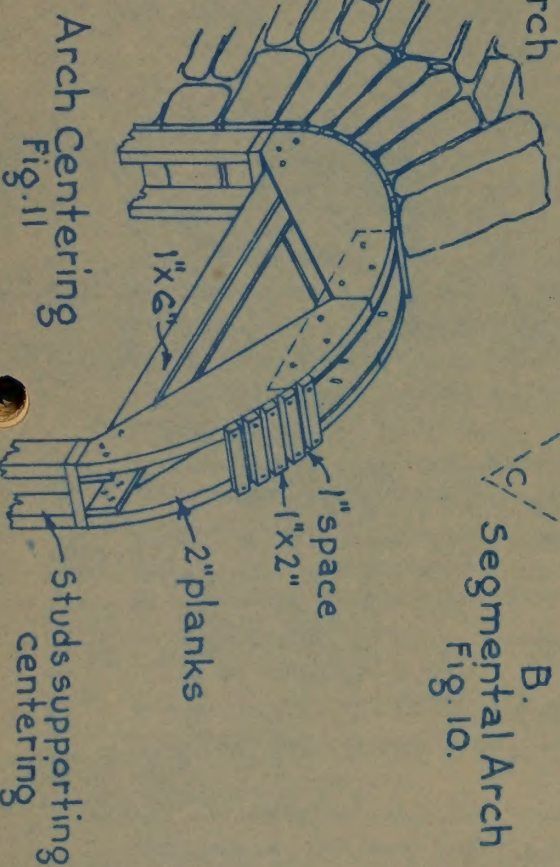
A.  
Semicircular Arch  
Fig. 10.



B.  
Segmental Arch  
Fig. 10.



C.  
Flat Arch  
Fig. 10.



Arch Centering  
Fig. 11

|                                      |         |                     |          |
|--------------------------------------|---------|---------------------|----------|
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| RUBBLE MASONRY                       |         |                     |          |
| Scale                                | CHECKED | SHEET 2 OF 2 SHEETS |          |
| Drawn by N.B.                        |         | SERIAL NO           |          |
| Traced by N.B.                       |         |                     |          |
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*Superseded by*  
*F.B. 1452*

UNITED STATES DEPARTMENT OF AGRICULTURE  
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INFORMATION SERIES No. 55.

JULY, 1924.

PAINTING.

THERE IS NO ONE KIND OF PAINT THAT IS SUITABLE FOR ALL MATERIALS, CLIMATES AND EXPOSURES. PAINT SHOULD BE PREPARED TO MEET DEFINITE REQUIREMENTS ACCORDING TO THE PURPOSE FOR WHICH IT IS INTENDED. THIS IS BEST DONE IN A WELL EQUIPPED FACTORY. WHEN A GOOD COMMERCIAL PAINT CAN BE OBTAINED IT IS QUESTIONABLE WHETHER AN INEXPERIENCED PAINTER DERIVES MUCH BENEFIT FROM MIXING HIS OWN MATERIALS. ONE ADVANTAGE OF HOME MIXED PAINT IS THE FACT THAT ITS COMPOSITION IS UNQUESTIONABLE PROVIDED GOOD PIGMENTS AND OILS HAVE BEEN PURCHASED. ALL PAINT SHOULD BE PURCHASED IN SEALED CONTAINERS BEARING THE MANUFACTURER'S NAME AND THE PROPORTIONS OF THE INGREDIENTS. PAINT MUST BE USED INTELLIGENTLY AND VARIED TO SUIT THE SURFACE TO BE PAINTED, THE WEATHER AND OTHER CONDITIONS.

THE LIQUID PORTION OF PAINT IS CALLED THE VEHICLE AND IS GENERALLY BETWEEN 35 AND 38 PER CENT OF THE WHOLE. ABOUT 90 PER CENT OF THE VEHICLE IS LINSEED OIL AND 10 PER CENT TURPENTINE AND DRIER. LINSEED OIL IS PROCURABLE IN THE RAW STATE OR BOILED. THE TWO MAY BE DIFFERENTIATED BY SPREADING A LITTLE OF EACH ON A GLASS SURFACE; THE BOILED OIL IS THE DARKER AND WILL DRY IN A DAY WHILE THE RAW OIL WILL REQUIRE 5 TO 16 DAYS. THE DRYING IS CAUSED BY ABSORPTION OF OXYGEN FROM THE AIR BY THE OIL AND THEIR CHEMICAL UNION. THE TOUGH LEATHERY FILM PRODUCED IN THE DRYING IS A VERY ESSENTIAL REQUIREMENT OF OILS SUITABLE FOR PAINTS. A SLOW DRYING PAINT IS MORE DURABLE THAN A QUICK DRYING ONE THEREFORE THE RAW OIL IS BEST FOR OUTSIDE AND GENERAL WORK BECAUSE IT DRIES SLOWER THAN BOILED OIL. UNDER CERTAIN CONDITIONS A QUICK DRYING PAINT IS NECESSARY AND BOILED OIL IS USED OR DRYING CAN BE EXPEDITED WHEN RAW OIL IS USED BY THE ADDITION OF JAPANS OR PAINT DRIER. THESE ARE SOLUTIONS OF CERTAIN METALLIC OXIDES IN OIL OR TURPENTINE, AND SHOULD BE FREE FROM ROSIN AND USED SPARINGLY (GENERALLY IN QUANTITIES BETWEEN 5 AND 10 PER CENT OF THE LIQUID CONTENT AND NEVER OVER 10 PER CENT).

WHEN IT IS DESIRED TO THIN PAINT TO A BETTER WORKING CONSISTENCY TURPENTINE IS THE BEST MATERIAL TO USE THOUGH BENZINE IS SOMETIMES EMPLOYED. TURPENTINE HAS TWICE THE THINNING POWER AS HAS LINSEED OIL. THESE THINNERS EVAPORATE AND DO NOT REMAIN IN THE DRIED FILM.

THE SOLID PORTION OF PAINT IS THE PIGMENT AND ITS FUNCTION IS TO HIDE THE SURFACE. PIGMENTS CAN BE PURCHASED AS A POWDER OR GROUND IN 10 PER CENT OIL MAKING A PASTE OR PUTTY. THE PASTE IS THE EASIEST KIND TO USE BECAUSE WITHOUT A GRINDER THE POWER IS RATHER TROUBLESOME TO MIX UNIFORMLY WITH THE OIL.

PAINTS MAY BE DIVIDED INTO TWO CLASSES, NAMELY, THE DULL REDS, BROWNS AND YELLOWS MADE WITH THE IRON OXIDES, AND THOSE IN WHICH A WHITE BASE IS USED. WHITE LEAD IS THE MOST RELIABLE AND COMMONLY USED WHITE PIGMENT BUT AFTER EXPOSURE TO AIR IT WILL IN TIME BECOME DRY AND POWDERY OR CHALKLIKE ON THE SURFACE. FIFTEEN POUNDS OF PASTE AND 6-1/2 POUNDS



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DIVISION OF ENTOMOLOGICAL RESEARCH

INVESTIGATION OF THE  
MAY 1924

There is no one kind of paint but in this case the materials  
employed are homogeneous. Paint should be prepared in such a way  
that it will adhere to the surface to which it is applied. This is  
done by a well known process. The paint is made of a mixture of  
oil and pigment. The oil is the vehicle and the pigment is the  
color. The paint is applied to the surface and it dries. The  
drying is done by the evaporation of the solvent. The paint  
then forms a film on the surface. This film is the paint.  
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paint then forms a film on the surface. This film is the paint.

When it is desired to paint a surface it is necessary to  
prepare the surface in such a way that it will receive the paint  
properly. This is done by cleaning the surface and removing all  
loose material. The surface is then primed with a coat of  
paint. This is done by applying a thin coat of paint to the  
surface. The paint is then allowed to dry. The surface is then  
ready to receive the final coat of paint.

The paint is made of a mixture of oil and pigment. The oil is  
the vehicle and the pigment is the color. The paint is applied  
to the surface and it dries. The drying is done by the  
evaporation of the solvent. The paint then forms a film on the  
surface. This film is the paint. The paint is made of a mixture  
of oil and pigment. The oil is the vehicle and the pigment is  
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film is the paint. The paint is made of a mixture of oil and  
pigment. The oil is the vehicle and the pigment is the color.

Paints are of various kinds. Some are made of oil and  
pigment. Some are made of water and pigment. Some are made  
of oil and water and pigment. The paint is applied to the  
surface and it dries. The drying is done by the evaporation  
of the solvent. The paint then forms a film on the surface.  
This film is the paint. The paint is made of a mixture of  
oil and pigment. The oil is the vehicle and the pigment is the  
color. The paint is applied to the surface and it dries. The  
drying is done by the evaporation of the solvent. The paint  
then forms a film on the surface. This film is the paint.



OF VEHICLE EQUAL 1 GALLON. WHITE ZINC (ZINC OXIDE) IS THE WHITEST OF ALL PIGMENTS AND MAKES A HARDER PAINT THAN WHITE LEAD BUT IT IS LIABLE TO PEEL OFF. IT IS WIDELY USED FOR INTERIOR ENAMELS AND FLAT PAINTS BUT IS NOT SUITABLE FOR OUTSIDE WORK. NINE AND ONE-HALF POUNDS WHITE ZINC PASTE AND 5-3/4 POUNDS VEHICLE EQUAL 1 GALLON. A MIXTURE OF WHITE LEAD AND ZINC WHITE IS BEST FOR EXTERIOR WORK AS THERE IS NOT THE TENDENCY OF THE ONE TO CHALK AND OF THE OTHER TO PEEL.

OTHER WHITE PIGMENTS ARE USED BY MANUFACTURERS. VARIOUS INERT MATERIALS ARE ADDED TO PAINTS TO MODIFY THEIR PHYSICAL QUALITIES. WHEN USED IN SMALL AMOUNTS (NOT OVER 15 PER CENT) BY REPUTABLE MANUFACTURERS, INSTEAD OF BEING OBJECTIONABLE THEY ARE BENEFICIAL; HOWEVER, GENERALLY THEY SHOULD NOT BE USED IN HAND-MIXED PAINTS BECAUSE OF THE IMPRACTICABILITY OF MAKING A THOROUGH MECHANICAL MIXTURE. THE MATERIALS COMMONLY EMPLOYED ARE MAGNESIA SILICATE (ASBESTINE), SILICA, BARYTES AND WHITING. THE LAST IS THE LEAST DESIRABLE AND IS USED EXTENSIVELY IN THE CHEAPER PAINTS UNDER A VARIETY OF NAMES.

MORE DURABLE RESULTS ARE OBTAINED WITH THE DARKER PAINTS THAN WITH THE LIGHTER TINTS OR WHITE; ALSO, IT IS THOUGHT THAT SEVERAL PIGMENTS COMBINED (EVEN THOUGH ALL ARE WHITE) GIVE BETTER SERVICE.

VARIOUS PIGMENTS ARE USED TO COLOR WHITE PAINT AND IT IS NOT PRACTICABLE TO GIVE THE EXACT QUANTITY THAT WILL PRODUCE A DEFINITE TINT BECAUSE THE STRENGTH OF A PIGMENT VARIES. THE APPENDED TABLE WILL SERVE AS A GUIDE; THE PROPORTIONS ARE FOR COLORS IN PASTE FORM ADDED TO 100 POUNDS OF PASTE WHITE LEAD, OR OTHER WHITE BASE DEPENDING UPON ITS PURPOSE, AND THINNED WITH THE VEHICLE AS INDICATED ELSEWHERE FOR DIFFERENT COATS AND KINDS OF MATERIALS.

THE ORDER OF MIXING IS IMPORTANT; THE PASTE SHOULD BE BROKEN UP WITH NO MORE OIL THAN IS NECESSARY, THE TINTING COLORS WELL STIRRED IN, THEN THE DRIER, THE REST OF THE OIL AND LAST, THE TURPENTINE. IF A READY-MIXED PAINT IS USED MOST OF THE OIL SHOULD BE DRAWN OFF AND THE PIGMENT THOROUGHLY STIRRED UP, GRADUALLY ADDING THE OIL WHICH WAS REMOVED.

ONE OF THE CHIEF REQUIREMENTS OF A SUCCESSFUL JOB OF WOOD PAINTING IS WELL SEASONED LUMBER. THE SURFACE TO BE PAINTED SHOULD BE DRY AND THE PAINTING SHOULD BE DONE WHEN THE ATMOSPHERE IS DRY AND PREFERABLY IN WARM WEATHER. SOME AUTHORITIES RECOMMEND COATING RESINOUS KNOTS WITH SHELLAC. WHILE THIS SHOULD ALWAYS BE DONE WHERE TIME SAVING IS A FACTOR IT IS BEST TO ALLOW RESINOUS WOODS TO WEATHER FOR SEVERAL MONTHS AS THE RESINS ARE THUS BROUGHT TO THE SURFACE AND HARDENED.

NEW WOODS GENERALLY REQUIRE THREE COATS WHILE THE NUMBER REQUIRED ON OLD WORK, OR WHERE SPECIAL FINISHES ARE DESIRED, DEPENDS UPON THE CONDITION OF THE SURFACE. EACH COAT SHOULD BE BRUSHED OUT TO A SMOOTH, UNIFORM AND THIN LAYER BECAUSE THREE THIN COATS ARE BETTER THAN TWO THICK ONES. THE FIRST COAT IS CALLED THE PRIMING COAT.







ALL WOODS BEING MORE OR LESS POROUS HAVE A TENDENCY TO ABSORB THE LIQUID AND THE PIGMENT IS LEFT ON THE SURFACE OF THE SOFTER WOODS WITHOUT A BINDER. TO OVERCOME THIS THE PRIMING COAT IS MADE THINNER THAN THE OTHERS BY ADDING 1 GALLON OF OIL TO 1 GALLON OF PAINT; A GOOD MIXTURE IS 100 POUNDS WHITE LEAD PASTE, 4 GALLONS RAW LINSEED OIL, 2 GALLONS TURPENTINE AND 1 PINT DRIER (MAKING ABOUT 9 GALLONS). YELLOW OCHRE OR ZINC WHITE SHOULD NOT BE USED FOR PRIMING. AS SOON AS THE PRIMING COAT IS DRY ALL HOLES AND CRACKS SHOULD BE FILLED WITH PUTTY COLORED TO MATCH THE PAINT THAT IS TO BE USED; WHITE LEAD PUTTY IS BEST AS IT DRIES VERY QUICKLY. THE BACKS OF ALL FRAMES WHICH ARE TO BE BUILT INTO MASONRY SHOULD BE PAINTED TO PREVENT ABSORPTION OF MOISTURE.

OUTSIDE WORK:- WHEN THE PRIMING COAT IS DRY THE SECOND COAT MAY BE APPLIED. AS THIS COAT SHOULD NOT DRY WITH A GLOSS, THE USE OF TURPENTINE IS DESIRABLE, A MIXTURE OF 100 POUNDS WHITE LEAD PASTE, 1-1/2 GALLONS RAW LINSEED OIL, 1-1/2 GALLONS TURPENTINE AND 1 PINT DRIER MAKING 6 GALLONS OF PAINT, IS RECOMMENDED. WHEN THIS COAT IS DRY THE THIRD COAT MAY BE APPLIED AND THE FOLLOWING MIXTURE IS SUGGESTED; 60 POUNDS WHITE LEAD PASTE, 40 POUNDS OF ZINC WHITE, 4-1/2 GALLONS RAW LINSEED OIL, 1 PINT TURPENTINE AND 1 PINT DRIER, MAKING ABOUT 7 GALLONS.

INSIDE WORK:- THE INSIDE WORK, EXCEPT WINDOW AND DOOR JAMBS, IS NOT EXPOSED TO THE ELEMENTS AND THEREFORE ANY GOOD PAINT WILL LAST FOR A LONG WHILE. THE SUN SHINING ON WINDOW JAMBS, ETC. QUICKLY AFFECTS THE PAINT AND FOR THIS REASON AN OUTSIDE PAINT IS PREFERABLE FOR SUCH SURFACES. THE MAIN POINT IN CHOOSING AN INSIDE PAINT IS TO SELECT ONE THAT WILL COVER WELL AND CONTAINS COLORS THAT ARE PERMANENT. VERY LIGHT TINTS OR BRILLIANT COLORS ARE LIKELY TO FADE WHILE WHITE PAINT CONTAINING LARGE QUANTITIES OF OIL WILL TURN YELLOW IN DARK ROOMS. THE PIGMENTS LITHOPONE AND ZINC WHITE ARE SUITABLE FOR INSIDE WORK. THE WOOD WORK SHOULD BE CLEAN AND SMOOTH AND THE FIRST COAT SHOULD BE APPLIED AS DESCRIBED FOR OUTSIDE WORK. THE FINISHING COATS DEPEND UPON THE CHARACTER OF SURFACE DESIRED. THE FOLLOWING MIXTURES ARE SUGGESTED FOR NEW WORK:

|                  | THIRD COAT. |            |                |           |         |  |
|------------------|-------------|------------|----------------|-----------|---------|--|
|                  | PRIMING     | 2ND COAT   | OIL GLOSS      | EGG SHELL | FLAT    |  |
| PASTE WHITE LEAD | 100 LB.     | 100 LB.    | 100 LB.        | 100 LB.   | 100 LB. |  |
| RAW LINSEED OIL  | 3 GAL.      | 1 1/2 GAL. | 3 1/2 GAL.     | 3/8 GAL.  |         |  |
| TURPENTINE       | 2 GAL.      | 1 1/2 GAL. | 2 PT.          | 2 PT.     | 3 GAL.  |  |
| DRIER            | 1 1/2 PT.   | 1 PT.      | 1 TO 1 1/2 PT. | 1/2 PT.   | 1/2 PT. |  |

THE EXCELLENCE OF THE FINISH DEPENDS UPON THE CARE AND THOROUGHNESS WITH WHICH EACH COAT IS SMOOTHED. BRUSH MARKS ARE REMOVED BY RUBBING WITH FINE SANDPAPER OR PUMICE AND LINSEED OIL.







REPAINTING:- THE CONDITION OF THE OLD SURFACE DETERMINES THE METHOD OF TREATMENT PREPARATORY TO REPAINTING. IF THE PAINT ADHERES WELL AND IS ONLY FADED OR CHALKY A COAT OF BOILED LINSEED OIL, OR RAW OIL WITH A LITTLE DRIER IN IT, IS ALL THAT IS NEEDED. THIS WILL RENEW THE PROTECTIVE QUALITY OF THE PAINT BUT WILL NOT RESTORE THE COLOR. WHERE THE PAINT IS LOOSE, CAKED OR PITTED SO AS TO PRESENT A ROUGH APPEARANCE IT SHOULD BE REMOVED BEFORE REPAINTING. IF THERE IS ANY CONSIDERABLE AREA OF PAINT TO BE REMOVED IT CAN BEST BE ACCOMPLISHED BY MEANS OF A PAINTERS' TORCH THE HEAT FROM WHICH SOFTENS THE PAINT SO THAT THE FILM IS EASILY SCRAPED OFF WITH A PUTTY KNIFE. CARE MUST BE TAKEN, IN USING A TORCH, NOT TO CHAR THE WOOD. SOMETIMES THE SURFACE CAN BE CONDITIONED BY BRUSHING OFF THE LOOSE PAINT WITH A WIRE BRUSH. ALL FINE DUST AND DIRT SHOULD BE REMOVED WITH A HAIR BRUSH BEFORE FRESH PAINT IS APPLIED. ORDINARY PAINT CAN BE REMOVED BY APPLYING HOUSEHOLD AMMONIA WITH A STIFF BRUSH UNTIL THE PAINT IS SOFTENED AND THEN SCRUBBING THE SURFACE WITH WATER. IF THE PAINT IS VERY HARD A SOLUTION OF 2 POUNDS OF SODA LYE IN 1 GALLON OF WATER CAN BE USED; AFTER THE PAINT HAS BEEN REMOVED THE SURFACE SHOULD BE WASHED WITH VINEGAR. THESE WASHES ARE LIKELY TO RAISE THE GRAIN OF THE WOOD AND SHOULD NOT BE USED WHEN THE EFFECT WOULD BE NOTICEABLE OR WHEN THE SURFACE CANNOT BE AGAIN SMOOTHED WITHOUT DAMAGE. --

COMMERCIAL PAINT REMOVERS, WHICH WILL NOT RAISE THE GRAIN, CAN BE PURCHASED. A GOOD PAINT REMOVER CAN BE PREPARED AS FOLLOWS: -

- 4 PARTS BENZOL.
- 3 PARTS AMYL ACETATE OR FUSEL OIL.
- 1 PART CARBON TETRACHLORIDE OR CHLOROFORM.

THIS REMOVER SHOULD BE USED ONLY WHERE THERE IS GOOD VENTILATION AND NO OPEN FLAME.

PAINTING PLASTERED WALLS:- AS NEW PLASTERED WALLS ARE ALKALINE AND DO NOT TAKE PAINT WELL IT IS ADVISABLE TO NOT PAINT THEM FOR A YEAR OR TWO. WHERE THIS DELAY IS NOT PRACTICABLE THE ALKALI CAN BE NEUTRALIZED TO A CERTAIN EXTENT BY WASHING THE SURFACE FIRST WITH A STRONG SOLUTION OF COMMON ALUM AND THEN WITH A SOLUTION OF SOAP. WHEN DRY THE PLASTER SHOULD AGAIN BE WASHED WITH WATER AND DRIED, WHEN IT CAN BE PAINTED. THE SURFACE OF PLASTER IS POROUS AND ABSORBS THE VEHICLE BEFORE THE PAINT CAN DRY; TO OVERCOME THIS THE WALL SHOULD BE SIZED OR PRIMED. THE SIZING MAY BE PREPARED BY SOAKING 1 POUND OF GLUE OVERNIGHT IN COLD WATER, POURING OFF THE WATER AND ADDING TO THE GLUE ENOUGH HOT WATER TO MAKE A GALLON. THIS SHOULD BE STIRRED AND 2 TO 4 OUNCES OF ALUM (DISSOLVED IN HOT WATER) ADDED. THE SIZE SHOULD BE APPLIED COLD. A GOOD PRIMING COAT IS MADE BY MIXING 70 POUNDS WHITE LEAD, 30 POUNDS ZINC WHITE, 8 GALLONS BOILED LINSEED OIL AND 1/2 TO 1 GALLON TURPENTINE. THE OTHER COATS MAY BE APPLIED AS DIRECTED FOR INTERIOR PAINTING.

MANUFACTURERS PREPARE SPECIAL PAINTS FOR INTERIOR WALLS AND WHEN THESE ARE USED THE DIRECTIONS SHOULD BE CAREFULLY FOLLOWED. COLD WATER PAINTS MAY BE USED WITH GOOD TEMPORARY RESULTS BUT ARE OBJECTIONABLE BECAUSE THEY SOIL EASILY AND RUB OFF. OIL PAINT SHOULD NOT BE APPLIED OVER A COLD WATER PAINT.



REPAIRING PLASTERED WALLS. The condition of the old surface determines the method of treatment necessary to repair it. If the paint is in good condition and is only faded or discolored, it may be removed by sanding or by using a fine sandpaper. If the paint is in poor condition, it may be removed by scraping or by using a wire brush. The surface should be cleaned and free of all dirt and grease before the new paint is applied. The new paint should be applied in two coats, the first coat being a primer and the second coat being the finish. The primer should be applied to the entire surface, and the finish should be applied to the areas where the old paint was removed. The finish should be applied in a uniform thickness, and it should be allowed to dry before the next coat is applied. The surface should be protected from moisture and frost during the drying process.

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- 1 part white lead
- 2 parts zinc oxide
- 3 parts white lead
- 4 parts white lead

THIS REMEDY SHOULD BE USED ONLY WHERE THERE IS GOOD VENTILATION AND NO OPEN FLAME.

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THE EASIEST WAY TO REMOVE PAINT FROM A PLASTER WALL IS THE ONE, USING LYE, DESCRIBED ABOVE. A PASTE SHOULD BE MADE OF THE SOLUTION BY ADDING LIME. THE PASTE IS SPREAD ON THE WALL HOT, LEFT FOR A WHILE AND THEN SCRAPPED OFF WITH A SCRAPER. SEVERAL APPLICATIONS MAY BE NECESSARY. AFTER THE PAINT HAS BEEN REMOVED THE WALL SHOULD BE WASHED WITH VINEGAR AND THEN SPONGED WITH CLEAR WATER.

EXIST

CONCRETE AND STUCCO:- FREE LIME AND ALKALI IN NEW CONCRETE BUT USUALLY DISAPPEAR IN A YEAR OR TWO. THE USE OF PATENTED PAINTS MADE TO RESIST ALKALI IS NOT NECESSARY IF THE CONCRETE SURFACE IS BRUSHED WITH A MIXTURE OF 5 TO 6 POUNDS OF ZINC SULPHATE DISSOLVED IN A GALLON OF WATER. WHEN THE SURFACE IS DRY ORDINARY OIL PAINT CAN BE APPLIED BUT IT IS BEST TO USE, IN THE FIRST COAT, A PAINT CONSISTING OF 100 POUNDS WHITE LEAD, 9 GALLONS OF BOILED LINSEED OIL AND 1 GALLON OF TURPENTINE. THE FOLLOWING COATS SHOULD CONTAIN ONLY ABOUT  $1/2$  THE ABOVE QUANTITY OF OIL ( $1/3$  BOILED AND  $2/3$  RAW) AND LITTLE OR NO TURPENTINE.

BRICKWORK:- BRICKWORK MUST BE THOROUGHLY DRY WHEN PAINT IS APPLIED. THE SUCTION MAY BE STOPPED SOMEWHAT BY FIRST APPLYING, 10 DAYS APART, 2 COATS OF RAW LINSEED OIL TO EACH GALLON OF WHICH  $1/2$  PINT OF OIL DRIER HAS BEEN ADDED. OTHER LIQUID DRIERS OR JAPANS SHOULD NOT BE USED. ORDINARY PAINT MAY THEN BE APPLIED.

STRUCTURAL METAL WORK:- CERTAIN PIGMENTS IN CONTACT WITH IRON AND STEEL STIMULATE CORROSION WHILE OTHERS CHECK OR RETARD IT. GRAPHITE IS CHEMICALLY ACTIVE WHEN USED IN DIRECT CONTACT WITH IRON AND THEREFORE CANNOT BE USED AS A PRIMING PIGMENT. RED LEAD AND VERMILLION ARE THE MOST COMMON AND EFFECTIVE PIGMENTS FOR PRIMING BUT HAVE LITTLE DURABILITY UNLESS PROTECTED BY MORE DURABLE PAINTS. RED LEAD SHOULD BE MIXED IN SMALL QUANTITIES AND JUST BEFORE IT IS APPLIED. AS A GOOD PRIMING MIXTURE THE FOLLOWING IS RECOMMENDED; 28 POUNDS RED LEAD (DRY),  $2/3$  GALLON RAW AND  $1/3$  GALLON BOILED LINSEED OIL,  $1/2$  PINT TURPENTINE. THE SECOND AND THIRD COATS MAY BE THE SAME BUT DARKENED WITH 4 OUNCES LAMP BLACK GROUND IN OIL, OR THE SECOND AND THIRD COATS MAY BE ANY HARD METALLIC PAINT LIKE PRINCES METALLIC OR GRAPHITE MADE WITH BOILED OIL.

ALL METAL SURFACES SHOULD BE THOROUGHLY CLEANED OF GREASE, LOOSE SCALE, RUST ETC. RUST AND SCALE CAN BE REMOVED BY SCRAPING WITH CHISELS OR WIRE BRUSHES AND GREASE BY WASHING WITH BENZINE. IT IS POOR ECONOMY TO SPARE LABOR IN CLEANING THE METAL.

TIN ROOF:- TIN ROOFS SHOULD FIRST BE CLEANED WITH SOAP AND WATER OR BENZINE. THE FIRST COAT OF PAINT SHOULD BE APPLIED AS SOON AS THE SURFACE IS DRY AND BEFORE RUSTING SETS IN. A GOOD PAINT IS MADE WITH IRON OXIDE OR METALLIC BROWN OR, IF DESIRED, THE PRIMING COAT MAY BE OF RED LEAD AS FOR STEEL WORK. IF 10% OF THE VEHICLE IS REPLACED WITH MENHADEN FISH OIL THE PAINT FILM DRIES SLOWER BUT WILL BE MORE ELASTIC AND DURABLE. THE DURABILITY OF THE TIN IS INCREASED BY PAINTING THE UNDER SIDE ONE COAT BEFORE IT IS LAID.







GALVANIZED METAL:- PAINT WILL NOT ADHERE TO GALVANIZED IRON UNLESS THE COATING OF GREASE IS REMOVED BY TREATMENT OR EXPOSURE TO THE WEATHER FOR AT LEAST NINE MONTHS. THE SURFACE OF NEW METAL MAY BE GIVEN A BRUSH COAT OF A SOLUTION CONSISTING OF 6 OUNCES OF COPPER ACETATE, CHLORIDE OR SULPHATE AND 1 GALLON OF WATER. AFTER 24 HOURS THE SURFACE WILL BE BLACKENED AND STIPPLED IN APPEARANCE AND ANY PAINT WILL READILY ADHERE. THE SURFACE SHOULD BE BRUSHED OFF BEFORE THE PAINT IS APPLIED.

ACID AND HEAT RESISTANT PAINT:- A PAINT THAT IS IMPERVIOUS TO GASES AND WATER AND HAS NO TENDENCY TO RUN UNDER A TEMPERATURE OF FROM 130 TO 140° F, CAN BE MADE FROM COAL-TAR AS FOLLOWS: COAL-GAS-TAR IS WELL BOILED TO EVAPORATE THE WATER AND CERTAIN OTHER SUBSTANCES AND THEN 20 TO 25% OF CAUSTIC QUICK-LIME IS SIFTED AND WELL STIRRED IN TO NEUTRALIZE THE ACID IN THE TAR. THIS MUST BE KEPT HOT FOR A FEW HOURS AND THEN AN EQUAL QUANTITY OF PORTLAND CEMENT IS SIFTED IN AND STIRRED THOROUGHLY. THE MIXTURE SHOULD BE APPLIED HOT TO CLEAN DRY SURFACES. SUCCESSIVE COATS CAN BE APPLIED AS SOON AS THE PROCEEDING ONES ARE DRY.

RADIATORS:- TESTS INDICATE THAT IT MAKES NO DIFFERENCE WHAT PAINTS OR COLORS ARE USED FOR THE FIRST COATS ON RADIATORS BUT THAT THE COLOR AND KIND OF PAINT USED FOR THE FINAL COAT HAS A MARKED INFLUENCE ON THE AMOUNT OF HEAT TRANSMITTED.

THE FOLLOWING TABLE SHOWS THE HEAT LOSS FROM A TWO-COLUMN 38" RADIATOR 10 SECTIONS LONG WHEN PAINTED WITH DIFFERENT KINDS OF PAINT AND WITH STEAM TEMPERATURE OF 215° F THE ROOM TEMPERATURE BEING 70° F.

| <u>CONDITION OF SURFACE</u>         | <u>PER CENT</u> |
|-------------------------------------|-----------------|
| CAST IRON BORE                      | 240             |
| PAINTED WITH ALUMINUM BRONZE        | 200             |
| PAINTED WITH GOLD BRONZE            | 205             |
| PAINTED WITH NO LUSTRE GREEN ENAMEL | 230             |
| PAINTED WITH MAROON JAPAN           | 240             |
| PAINTED WITH WHITE ENAMEL           | 242             |
| PAINTED WITH WHITE ZINC PAINT       | 242             |

FROM THIS TABLE IT CAN BE NOTED THAT THE PRACTICE OF PAINTING RADIATORS WITH GOLD AND ALUMINUM BRONZE IS AT THE SACRIFICE OF RADIATION.

SHINGLES:- WOOD SHINGLES MAY BE PROTECTED, AFTER THEY ARE LAID, WITH LEAD AND OIL PAINT OR BRUSH COATS OF CREOSOTE PRESERVATIVE BUT THE BEST RESULTS ARE OBTAINED BY DIPPING, IN CREOSOTE BEFORE LAYING. WHERE THE NATURAL COLOR OF CREOSOTE IS OBJECTIONABLE IT CAN BE VARIED BY THE USE OF PIGMENTS SUCH AS THE SIENNAS, UMBERS AND IRON OXIDES. FOR RED AND GREEN ONLY THE VERY BEST PIGMENTS SHOULD BE USED BECAUSE OF THEIR TENDENCY TO FADE. CREOSOTE SHOULD NOT BE THINNED WITH CRUDE OIL OR KEROSENE; IF TOO THICK IT MAY BE THINNED BY WARMING, PRECAUTIONS AGAINST FIRE BEING TAKEN. THE SHINGLES SHOULD BE THOROUGHLY DRY WHEN DIPPED AND SHOULD BE IMMERSSED  $\frac{2}{3}$  OF THE LENGTH; AFTER DIPPING THEY SHOULD BE THROWN LOOSELY IN A PILE TO DRY. A GALLON OF STAIN WILL DIP FROM 350 TO 450 SHINGLES. AFTER THE SHINGLES ARE ON THE ROOF IT IS BEST TO GIVE THEM A BRUSH COAT OF STAIN; ONE GALLON WILL COVER 200 TO 300 SQ. FT.



**PAINTING DETAILS.** PAINT WILL NOT ADHERE TO GALVANIZED IRON UNLESS THE COATING OF OIL OR GREASE IS REMOVED BY TREATMENT OF THE SURFACE FOR AT LEAST NINE MONTHS. THE SURFACE OF NEW METAL MAY BE GIVEN A BRUSH COAT OF A SOLUTION CONSISTING OF 2 OUNCES OF COPPER ACETATE, CHLORIDE OF COPPER AND 1 GALLON OF WATER. AFTER 24 HOURS THE SURFACE WILL BE GLAZED AND STIRRED IN APPROPRIATE AND ANY PAINT WILL READILY ADHERE. THE SURFACE SHOULD BE FINISHED OFF BEFORE THE PAINT IS APPLIED.

**PAINT AND PAINT MATERIALS.** A PAINT THAT IS IMPERVIOUS TO WATER AND HAS NO TENDENCY TO RUN UNDER A TEMPERATURE OF FROM 100 TO 140° F. CAN BE MADE FROM COAL-TAR OR ROUGHENED COAL-TAR IS WELL BOILED TO EVAPORATE THE WATER AND CERTAIN OTHER SUBSTANCES AND THEN 50 TO 75% OF CAMPHOR OIL OR CAMPHOR OIL IS ADDED AND WELL STIRRED IN TO NEUTRALIZE THE ACID IN THE TAR. THIS MUST BE KEPT HOT FOR A FEW HOURS AND THEN AN EQUAL QUANTITY OF PORTLAND CEMENT IS SIFTED IN AND STIRRED THOROUGHLY. THE MIXTURE SHOULD BE APPLIED HOT TO CLEAN DRY SURFACES. SUCCESSIVE COATS CAN BE APPLIED AS SOON AS THE PRECEDING ONE IS DRY.

**TESTS.** TESTS INDICATE THAT IT MAKES NO DIFFERENCE WHAT PAINTS OR COLORED ARE USED FOR THE FIRST COATS OF RADIATORS BUT THAT THE COLOR AND KIND OF PAINT USED FOR THE FINAL COAT HAS A MARKED INFLUENCE ON THE AMOUNT OF HEAT TRANSMITTED.

THE FOLLOWING TABLE SHOWS THE HEAT LOSS FROM A TWO-COLUMN 32" RADIATOR 10 SECTIONS LONG WHEN PAINTED WITH DIFFERENT KINDS OF PAINT AND WITH ROOM TEMPERATURE OF 55° F. THE ROOM TEMPERATURE BEING 70° F.

| PER CENT |                                       |
|----------|---------------------------------------|
| 100      | PAINTED WITH WHITE ZINC PAINT         |
| 95       | PAINTED WITH WHITE TUMBLE             |
| 90       | PAINTED WITH VARNISH                  |
| 85       | PAINTED WITH OIL AND THE GREEN SWARTZ |
| 80       | PAINTED WITH GOLD BRONZE              |
| 75       | PAINTED WITH ALUMINUM BRONZE          |
| 70       | PAINTED WITH WHITE ZINC PAINT         |

FROM THIS TABLE IT CAN BE NOTED THAT THE PHANTOM OF PAINTING RADIATORS WITH GOLD AND ALUMINUM BRONZE IS BY THE CHARACTER OF RADIATION.

**CHIMNEYS.** ROSS CHIMNEYS MAY BE PROTECTED, AFTER THEY ARE LAID, WITH LEAD AND OIL PAINT OR BRUSH COATS OF COPPER ACETATE AND THE BEST RESULTS ARE OBTAINED BY DIPPING IN COPPER ACETATE LAYING. THE NATURAL COLOR OF COPPER IS QUARTZ-LIKE IT CAN BE VARNISHED BY THE USE OF VARNISHES SUCH AS THE VARNISH, OILS AND IRON OILS. FOR RED AND GREEN ONLY THE VERY BEST PIGMENTS SHOULD BE USED BECAUSE OF THEIR TENDENCY TO FAD. COPPER SHOULD NOT BE MIXED WITH COARSE SILICA OR KEROSENE; IT IS NOT THICK IT MAY BE THIN BY VARNISHING, FOLLOWING AGAINST THE BEING TAKEN. THE MINOR SHOULD BE THOROUGHLY LAY WHEN DIPPED AND SHOULD BE IMMEDIATELY OF THE CHIMNEY AFTER DIPPING THEY SHOULD BE THROWN LOOSELY IN A BULK TO DRY. A GALLON OF OIL WILL DO FROM 350 TO 450 CHIMNEYS. AFTER THE CHIMNEYS ARE ON THE ROOF IT IS BEST TO GIVE THEM A BRUSH COAT OF OIL; ONE GALLON WILL COVER 450 TO 500 SQ. FT.



CANVAS ROOF:- TEN OUNCE DUCK IS GENERALLY USED. IT SHOULD BE NAILED DOWN CARE BEING TAKEN TO DRAW IT SMOOTH AND TIGHT; A FEW SLIGHT WRINKLES MAY BE UNAVOIDABLE BUT THEY WILL DISAPPEAR WITH THE TREATMENT. THE CANVAS SHOULD BE SOAKED THOROUGHLY AFTER IT IS NAILED IN PLACE; AS SOON AS THE SURPLUS WATER HAS DISAPPEARED BUT WHILE THE CANVAS IS STILL WET IT SHOULD BE PAINTED WITH A GOOD OUTSIDE PAINT. THIS PAINTING OVER A WET SURFACE IS AN EXCEPTION TO ALL PAINTING PRACTICE AND IS DONE TO PERMIT THE PAINT TO PENETRATE THE FABRIC. SEE FARMERS' BULLETIN 1157, "WATER-PROOFING AND MILDEW-PROOFING OF COTTON DUCK."

FLOOR TREATMENT:- SEE FARMERS' BULLETIN 1219, "FLOOR AND FLOOR COVERINGS."

FIRE RETARDANT PAINT:- ORDINARY PAINT CAN BE MADE TO DELAY COMBUSTION BY ADDING 1 POUND OF POWDERED BORACIC ACID TO EACH GALLON OF PAINT. WHEN STRONGLY HEATED THIS MATERIAL FUSES AND FORMS A SORT OF GLASS WHICH KEEPS AIR FROM THE WOOD; HOWEVER AFTER A TIME IT WILL WASH OUT NECESSITATING REPAINTING IF PROTECTION FROM FIRE IS TO BE RENEWED.

CLEANING BRUSHES:- PAINT HARDENED BRUSHES MAY BE CLEANED BY SOAKING THEM IN STRONG WASHING SODA AND WATER. WHEN THE PAINT HAS BECOME SOFT THE BRUSHES SHOULD BE WASHED WITH STRONG SOAP AND WATER. THE HARDEST PAINT CAN BE REMOVED FROM BRUSHES BY SOAKING THEM IN HOT KEROSENE. THE KEROSENE SHOULD BE HEATED IN A CAN SET IN A CONTAINER OF BOILING WATER; THE WATER, AS IT COOLS, SHOULD BE REPLACED WITH MORE HOT WATER. ACETONE OR OTHER PAINT REMOVERS CAN ALSO BE USED. BRUSHES SHOULD BE CLEANED BEFORE BEING PUT AWAY. THEY MAY BE KEPT SOFT FOR A SHORT WHILE BY HANGING THEM IN TURPENTINE OR KEROSENE CARE BEING TAKEN NOT TO LET THEM REST ON THE ENDS OF THE BRISTLES. WHEN KEROSENE IS USED ALL TRACES OF IT SHOULD BE WASHED OUT WITH SOAP AND WATER BEFORE PAINTING IS RESUMED.

PUTTY:- THE AVERAGE PUTTY IS BADLY ADULTERATED. A GOOD GRADE OF PUTTY CAN BE MADE BY THOROUGHLY MIXING PURE WHITING WITH LINSEED OIL TO THE CONSISTENCY OF DOUGH. PUTTY FOR GLAZING SHOULD CONTAIN ABOUT 10% WHITE LEAD PASTE WHICH CAUSES IT TO ADHERE WELL AND SET QUICKER. PUTTY WILL NOT ADHERE TO UNPRIMED WOOD. IT CAN BE COLORED WITH ORDINARY PIGMENTS.

A CONCENTRATED SOLUTION OF LYE (CAUSTIC SODA) APPLIED WITH A SMALL BRUSH TO OLD DRY PUTTY WILL SOFTEN IT SO THAT IT MAY BE REMOVED EASILY WITHIN AN HOUR.

CRACK FILLER:- CRACKS IN OLD FLOORS OR OTHER WOOD WORK MAY BE FILLED WITH THE FOLLOWING MIXTURE WHICH WILL DRY HARD, STAND SANDPAPERING AND SHRINK VERY LITTLE; 1/2 POUND FLOUR, 1-1/2 QUARTS WATER AND 1/2 OUNCE ALUM MIXED WITH ENOUGH TISSUE PAPER TO MAKE A THICK PUTTY. THE MIXTURE MAY BE COLORED AS DESIRED WITH ORDINARY PIGMENTS.

BLACKBOARD PAINT:- A PAINT WHICH DRIES FAST AND MUST BE HANDLED QUICKLY CONSISTS OF 1 QUART JAPAN DRIER; 1 PINT TURPENTINE; 1/2 POUND POWDERED PUMICE STONE; 1/2 POUND DROP BLACK; 1 OUNCE ULTRAMINE BLUE (IN OIL).







FARM MACHINERY PAINT:- A PAINT THAT WILL RESIST GREASE AND STAND VARYING TEMPERATURES CAN BE MADE BY MIXING  $12\frac{1}{2}$  POUNDS OF FRENCH ZINC PASTE;  $1\frac{1}{2}$  POUND LAMPBLACK PASTE;  $1\frac{1}{2}$  GALLONS GUM JAPAN DRIER.

THE QUANTITY OF PAINT REQUIRED TO COVER A GIVEN AREA DEPENDS UPON THE NATURE AND CONDITION OF THE SURFACE, THE WEATHER, THE CONSISTENCY OF THE PAINT AND THE THOROUGHNESS OF THE BRUSHING OUT. IN GENERAL THE ALLOWANCE IS ONE GALLON TO 400 TO 500 SQUARE FEET OF SURFACE FOR EACH COAT. A GALLON WILL COVER 600 TO 800 SQUARE FEET OF METAL SURFACE.

THE LABOR COST IS THE MOST EXPENSIVE ITEM OF A PAINTING JOB; IT IS THEREFORE ADVISABLE TO USE A GOOD GRADE OF PAINT AS THE INITIAL SAVING DUE TO THE USE OF CHEAP PAINT, IS SMALL AND THE RESULT IS NOT LASTING. IN ESTIMATING, THE COST OF APPLICATION MAY BE TAKEN AS  $1\frac{1}{2}$  TO 2 TIMES THE COST OF THE PAINT.

TARRED SURFACES MAY BE PAINTED IF FIRST GIVEN A COAT OF SHELLAC OR VARNISH.

IF THE WOOD WORK FROM WHICH PAINT HAS BEEN REMOVED IS DISCOLORED IT CAN BE BLEACHED WITH OXALIC ACID DISSOLVED IN WATER.

QUANTITY OF PASTE PIGMENT REQUIRED TO PRODUCE INDICATED COLORS  
WHEN MIXED WITH 100 POUNDS OF WHITE LEAD PASTE.

|                  |                                                                                 |
|------------------|---------------------------------------------------------------------------------|
| IVORY YELLOW     | 1 oz. MEDIUM CHROME YELLOW.                                                     |
| PALE YELLOW      | 7 oz. MEDIUM CHROME YELLOW.                                                     |
| DULL GRAY        | 1 oz. LAMP BLACK.                                                               |
| UMBER            | 2 TO 20 LB. RAW UMBER.                                                          |
| LIGHT BLUE       | $\frac{1}{4}$ oz. LAMP BLACK - $1\frac{1}{5}$ oz. PRUSSIAN BLUE.                |
| COLONIAL YELLOW  | 2 LB. MEDIUM CHROME YELLOW - 1 LB. RAW SIENNA.                                  |
| MOSS GREEN       | 20 LB. MEDIUM CHROME YELLOW - 38 LB. RAW UMBER.                                 |
| BUTTERCUP YELLOW | 8 oz. MEDIUM CHROME YELLOW - 5 oz. FRENCH OCHRE.                                |
| FRENCH GRAY      | 4 oz. LAMP BLACK - 2 oz. RAW UMBER                                              |
| DRAB             | 1 LB. MEDIUM CHROME YELLOW - 4 LB. FRENCH OCHRE.                                |
| DARK SLATE       | 7 oz. LAMP BLACK - 11 oz. MEDIUM CHROME YELLOW.                                 |
| BUFF             | 5 LB. 10 oz. FRENCH OCHRE - $4\frac{1}{5}$ oz. VENETIAN RED.                    |
| CREAM            | 2 LB. 1 oz. FRENCH OCHRE - $\frac{3}{4}$ oz. VENETIAN RED.                      |
| YELLOW BROWN     | 1 oz. LAMP BLACK - 7 LB. 8 oz. FRENCH OCHRE.                                    |
| QUAKER DRAB      | 2 oz. LAMP BLACK - 2 LB. 12 oz. FRENCH OCHRE.                                   |
| GRAY STONE       | 1 oz. LAMP BLACK - 12 oz. FRENCH OCHRE.                                         |
| PEA GREEN        | 4 oz. LAMP BLACK - $12\frac{1}{2}$ oz. MEDIUM CHROME YELLOW - 2 LB.             |
|                  | 1 oz. MEDIUM CHROME GREEN.                                                      |
| SEA GREEN        | $1\frac{1}{2}$ oz. LAMP BLACK - 5 oz. MEDIUM CHROME YELLOW - 2 oz.              |
|                  | MEDIUM CHROME GREEN.                                                            |
| DARK IVY GREEN   | $3\frac{3}{4}$ oz. LAMP BLACK - 2 LB. $6\frac{1}{2}$ oz. MEDIUM CHROME YELLOW - |
|                  | 21 LB. LIGHT GREEN.                                                             |
| DULL OLIVE       | 1 LB. 6 oz. LAMP BLACK - 4 LB. 10 oz. MEDIUM CHROME                             |
|                  | YELLOW - 4 LB. 9 oz. MEDIUM CHROME GREEN.                                       |
| DELFT BLUE       | 3 oz. LAMP BLACK - 1 LB. 2 oz. MEDIUM CHROME GREEN -                            |
|                  | 1 LB. $6\frac{1}{2}$ oz. PRUSSIAN BLUE.                                         |



PAINTS FOR MACHINERY A PAINT THAT WILL RESIST OIL AND STAND  
VARYING TEMPERATURES CAN BE MADE BY MIXING 100 POUNDS OF FRENCH TIND  
PASTE; 1/2 POUND LAMPBLACK PASTE; 1/2 GALLON OF LAMP OIL.

THE QUANTITY OF PAINT REQUIRED TO COVER A GIVEN AREA DEPENDS  
UPON THE NATURE AND CONDITION OF THE SURFACE, THE WEATHER, THE CONSIST-  
ENCY OF THE PAINT AND THE THICKNESS OF THE BRUSHING OUT. IN GENERAL  
THE ALLOWANCE IS ONE GALLON TO 400 TO 500 SQUARE FEET OF SURFACE FOR EACH  
COAT. A GALLON WILL COVER 100 TO 150 SQUARE FEET OF METAL SURFACE.

THE LABOR COST IS THE MOST EXPENSIVE ITEM OF A PAINTING JOB.  
IT IS THEREFORE ADVISABLE TO USE A GOOD GRADE OF PAINT AS THE INITIAL SAVING.  
DUE TO THE USE OF CHEAP PAINT, IS WASTE AND THE RESULT IS NOT LASTING.  
IN ESTIMATING, THE COST OF APPLICATION MAY BE TAKEN AS 1/2 TO 1 TIMES THE  
COST OF THE PAINT.

TARNISHED SURFACES MAY BE PAINTED IN FIRST GIVEN A COAT OF SHELING  
OR VARNISH.

IF THE WORK FROM WHICH PAINT HAS BEEN REMOVED IS DISCOLORED  
IT CAN BE BLENDED WITH OXALIC ACID DISSOLVED IN WATER.

QUANTITY OF PASTE REQUIRED TO PRODUCE INDICATED COLORS  
WHEN MIXED WITH 100 POUNDS OF WHITE LEAD PASTE.

|                                                           |                  |
|-----------------------------------------------------------|------------------|
| 1 oz. medium chrome yellow.                               | ivory yellow     |
| 7 oz. medium chrome yellow.                               | pale yellow      |
| 1 oz. lamp black.                                         | full gray        |
| 2 to 20 lb. raw umber.                                    | umber            |
| 2 oz. lamp black = 1/2 oz. Prussian blue.                 | light blue       |
| 2 lb. medium chrome yellow = 1 lb. raw umber.             | colonial yellow  |
| 50 lb. medium chrome yellow = 50 lb. raw umber.           | rose green       |
| 2 oz. medium chrome yellow = 2 oz. French chrome.         | buttercup yellow |
| 4 oz. lamp black = 2 oz. raw umber.                       | French gray      |
| 1 lb. medium chrome yellow = 4 lb. French chrome.         | lake             |
| 7 oz. lamp black = 1/2 oz. medium chrome yellow.          | dark slate       |
| 2 lb. 10 oz. French chrome = 1/2 oz. Venetian red.        | rust             |
| 2 lb. 1 oz. French chrome = 3/4 oz. Venetian red.         | cream            |
| 1 oz. lamp black = 7 lb. 3 oz. French chrome.             | yellow brown     |
| 2 oz. lamp black = 2 lb. 10 oz. French chrome.            | gunner's gray    |
| 1 oz. lamp black = 12 oz. French chrome.                  | gray stone       |
| 2 oz. lamp black = 1 1/2 oz. medium chrome yellow = 2 lb. | sea green        |
| 1 oz. medium chrome yellow.                               | sea green        |
| 1 1/2 oz. lamp black = 2 oz. medium chrome yellow = 2 lb. | dark ivy green   |
| medium chrome green.                                      |                  |
| 1/2 oz. lamp black = 2 lb. 1/2 oz. medium chrome yellow = | full olive       |
| 21 lb. light green.                                       | light blue       |
| 1 lb. 2 oz. lamp black = 2 lb. 1/2 oz. medium chrome      |                  |
| yellow = 4 lb. 2 oz. medium chrome green.                 |                  |
| 2 oz. lamp black = 1 lb. 2 oz. medium chrome green =      |                  |
| 1 lb. 1/2 oz. Prussian blue.                              |                  |



I. S. No. 55.

|                 |                                                                            |
|-----------------|----------------------------------------------------------------------------|
| MEDIUM BROWN    | 14 LB. RAW SIENNA - 24 LB. BURNT UMBER - 15 LB. BURNT SIENNA.              |
| CHOCOLATE BROWN | 4 OZ. MEDIUM CHROME YELLOW - 24 LB. BURNT UMBER - 10 LB. BURNT SIENNA.     |
| NEUTRAL GRAY    | 5 OZ. LAMP BLACK - 1 LB. 1 OZ. FRENCH OCHRE - 4/10 OZ. VENETIAN RED.       |
| DARK DRAB       | 2 LB. LAMP BLACK - 22 LB. FRENCH OCHRE - 1 LB. VENETIAN RED.               |
| MUSHROOM        | 1/2 OZ. LAMP BLACK - 2 LB. 3 OZ. FRENCH OCHRE - 3/10 OZ. VENETIAN RED.     |
| EARTH BROWN     | 1 LB. 8 OZ. LAMP BLACK - 32 LB. FRENCH OCHRE - 2 LB. 9 OZ. VENETIAN RED.   |
| TAN             | 3/4 OZ. LAMP BLACK - 6 OZ. FRENCH OCHRE - 4 1/2 OZ. VENETIAN RED.          |
| LIGHT BROWN     | 1-3/10 OZ. LAMP BLACK - 5 LB. 9 OZ. FRENCH OCHRE - 4 1/2 OZ. VENETIAN RED. |

U. S. ARMY DRABS.

|                           | <u>OLIVE DRAB</u> | <u>MEDIUM DRAB</u> | <u>LIGHT DRAB</u> |
|---------------------------|-------------------|--------------------|-------------------|
| FRENCH OCHRE IN PASTE     | 25 1/2 LB.        | 11 LB.             | 25 LB.            |
| LAMP BLACK IN PASTE       | 5 1/4 LB.         | 2 1/2 OZ.          | 1 OZ.             |
| MEDIUM CHROME GREEN PASTE | 15 1/4 LB.        |                    |                   |
| RAW LINSEED OIL           | 5 GAL.            | 2-1/8 GAL.         | 3-3/8 GAL.        |
| TURPENTINE                | 1 PT.             | 1/2 PT.            | 1/2 PT.           |
| DRIER                     | 1 QT.             | 1 PT.              | 3/4 PT.           |
| WHITE LEAD PASTE          |                   | 25 LB.             |                   |







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 56.

April, 1925.

HOMEMADE CONCRETE BLOCKS

The average person looks upon a concrete block as an artificial stone having two holes in it and possibly an imitation rock pitch face. The intrinsic merits of concrete blocks properly made and used are recognized by all builders.

In casting homemade blocks one should not attempt to attain cheapness by skimping in materials and necessary labor. Low cost is essential and can be secured by judicious buying of materials, planning the equipment and conduct of the work and by duplication of units. It is highly desirable from the cost standpoint that as many blocks as possible be of the same size and shape yet architectural effect or interior arrangement of the plan should not be sacrificed to this consideration. The blocks should be of such size that they will fit the design, or, as may often be done, the design should be based on one or more unit sizes of block. Special sizes may sometimes be required for the walls between openings or elsewhere in order that windows and doors may be located to the best advantage with respect to convenience or effect.

Concrete has a characteristic appearance which when properly and suitably developed is very acceptable architecturally and there should be no attempt to use concrete in imitation of other materials. If stone quarries or brick kilns can supply masonry materials at a reasonable cost, delivered to the site their use should be weighed with the cost of producing a good block. The ingredients and labor required in making good concrete blocks should not be skimped in an effort to compete with other building materials.

Several different types of blocks have resulted from efforts to economize in materials, provide insulation in the form of airspaces, adapt the block unit to bonding in different thicknesses of walls, obtain maximum bond strength and to establish patent rights on special shapes. The simplest type is the solid block which has a place in heavy engineering construction but is not suitable for buildings, on account of its weight, uneconomical use of materials and the fact that moisture will penetrate the walls causing damp interiors. In an attempt to overcome the last disadvantage hollow walls were made by casting separate slabs and tying them by metal strips to bearing walls. This method produced dry interior walls that could be plastered upon directly but the metal ties rusted. The one piece hollow block was next introduced and is the type most commonly used at present even though the walls must be furred because of dampness penetrating through the webs and joints. Blocks shaped like the letters T, U, E, and L, known as two-piece blocks, and laid so that no single unit extends through the wall have been designed to overcome this objection to the one-piece block. Both one and two-piece blocks are made with patented features intended to prevent or impede the passage of water. For ordinary farm construction the hollow and T-shaped blocks meet most demands and are easily made and laid.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF ENTOMOLOGY  
DIVISION OF ENTOMOLOGICAL RESEARCH

April, 1928.

Information Series No. 55

ENTOMOLOGICAL RESEARCH

The various persons look upon a concrete block as an artificial stone. It is not, however, an artificial stone. It is a natural stone, the natural stone of concrete blocks, properly made and used, are recognized by all nations.

In making concrete blocks one should not attempt to obtain shape by means of a mold. It is necessary and necessary labor. It is not a natural stone and can be made by various means of materials, including the use of sand and cement of the same and a proportion of water. It is highly resistant to fire from the concrete block as any block is possible to be of the same size and shape for architectural effect or interior arrangement of the place should not be qualified as this consideration. The block should be of such size that it will fit the design, or, as may often be done, the design should be based on one or more units of block. Special sizes may sometimes be required for the walls between openings or elsewhere in order that windows and doors may be located to the best advantage with respect to appearance or effect.

Concrete has a characteristic appearance which when properly and suitably developed is very acceptable architecturally and there should be no attempt to use concrete in imitation of other materials. It is a natural stone or brick like the heavy masonry and it is a reasonable cost delivered to the site. It should be weighed with the cost of producing a good block. The architect and interior decorator in making good concrete blocks should not be urged in an effort to compete with other building materials.

General different types of blocks have resulted from efforts to economize in materials, provide insulation in the form of air spaces, shape the block into a form in different thicknesses of walls, obtain maximum heat absorption and in established rights on special shapes. The air space type is the solid block which has a space in heavy engineering construction but is not suitable for buildings on account of its weight. An economical use of materials and the fact that concrete will penetrate the walls causing dampness. It is an attempt to overcome this fact by making hollow walls with voids made by casting separate slabs and tying them by metal strips or facing walls. This method produces dry interior walls that could be plastered or finished. But the metal ties must be one place hollow block was not introduced and in the most common use at present even though the walls must be covered by dampness penetrating through the walls and joints. Blocks shaped like the letters T, U, E, and L, known as two-place blocks, and laid so that an air space extends through the wall have been suggested to overcome this objection to the one-place block. Both of these methods are made with galvanized iron intended to prevent or impede the passage of water. For ordinary form construction the hollow walls should be made with dampers and are easily made and laid.



In addition to the regular shapes, one-half, one-fourth and corner blocks will be required. Lintels are essential over openings and should be of solid reinforced concrete cast in place or precast and built into the wall. Sills, copings and special shapes as may be required to break joints in the bond or to form jambs and corners can be readily precast.

The size of the block is limited by its weight for a unit weighing over 100 pounds cannot be handled with ease by one man; a block weighing not over 75 or 80 pounds is preferred. The most common dimensions of blocks are nominally 8 x 8 x 16 inches though they may vary from 8 to 12 inches thick 8 to 12 inches high and 16 to 32 inches long. Blocks 24 inches long make a wall of more pleasing appearance than do short blocks. Concrete blocks should be laid in cement mortar with joints  $\frac{1}{4}$  to  $\frac{1}{2}$  inch thick. Care should be taken to see that each joint is completely filled with mortar in order to secure the greatest strength of wall. The T-shaped block has much to recommend it. In the wall it is of the same appearance as a one piece block but affords better insulation and a stronger bond.

In selecting the materials for concrete block suitability of the various kinds, as outlined in Farmers' Bulletin 1279, should be considered. Portland cement is the only kind to use in blocks for general work and only one brand should be used on a job because the shade varies with the different brands, a fact that is of importance especially in making faced blocks where uniformity of color is desired.

There is no standard proportion for mixing the ingredients, the chief aim being to fill all the voids and to obtain the requisite strength using the minimum amount of cement. Various recommendations have been made by authorities and the building regulations of some cities specify physical tests which the finished blocks shall meet. Recommended mixtures vary from 1:3 mortar to 1:3:5 concrete but when the weaker mixtures are used it is the custom to face the blocks with  $\frac{1}{2}$  to  $\frac{3}{4}$  inch of rich mortar or concrete, 1:2 or 1:1:1. If no facing is to be applied either a 1:4 mortar or 1:2:4 concrete had best be used for the whole block. It is more economical to use a mixture that makes bulk therefore, a 1:2:4 concrete is cheaper than a 1:4 mortar because there is a greater number of cubic feet in the former per bag of cement. The average block contains about 33% airspace or hollows so that a bag of cement mixed 1:4 will make  $8\frac{1}{2}$  blocks while one mixed 1:2:4 will make  $10\frac{3}{4}$  blocks. Knowing the quantity of mortar obtained from various mixtures and the exact volume of concrete in any type of block the number of blocks that can be made from 1 bag of cement is easily determined.

Blocks can be made by the wet or the dry process. A concrete thoroughly mixed to a plastic consistency is stronger and more impervious than one mixed dry but a greater number of forms are required since the blocks must set from 10 to 12 hours before they can be stored thus adding to the cost of equipment and requiring more space to operate a plant. A dry mixture can be tamped or pressed sufficiently to keep its shape thus permitting the block to be removed from the mold immediately and carried



The addition of the various types of aggregate and cement should be regulated. It is essential over operations and should be of solid material. The aggregate should be of such size that the wall, ceiling and special areas may be required to break pieces in the bond or to form joints and corners can be readily prepared.

The size of the block is limited by the weight. A wall weighing over 100 pounds cannot be handled with ease by one man. A block weighing not over 75 to 80 pounds is preferred. The most common dimensions of blocks are nominally 8 x 8 x 8 inches though they may vary from 6 to 12 inches thick. A wall of more pleasing appearance than the above blocks. Concrete blocks should be laid in cement mortar with joints 1/2 to 1 inch thick. Care should be taken to see that each joint is completely filled with mortar in order to secure the greatest strength of wall. The T-shaped block has much to recommend it. In the wall it is of the same size as a one piece block but efforts at joint insulation and a stronger bond.

In selecting the material for concrete block satisfactory of the various kinds, as outlined in Bureau Bulletin 1379, should be considered. Portland cement is the only kind to use in blocks for general work and only one brand should be used on a job because the grade varies with the different brands. It is of importance especially in making faced blocks where uniformity of color is desired.

There is no standard proportion for mixing the ingredients. The chief aim being to fill all the voids and to obtain the required strength using the minimum amount of cement. Various recommendations have been made by engineers and the building regulations of some cities specify minimum loads with the finished blocks shall meet. Recommended mixtures vary from 1:2 mortar to 1:3:5 concrete but when the weaker mixtures are used it is the custom to face the blocks with 1/2 to 3/4 inch of vitrified or cement, 1:2 or 1:1. It is feeling is to be applied either a 1/2 mortar or 1:3:5 concrete but best be used for the whole block. It is also economical to use a mixture that makes with mortar as 1:2:4 concrete is stronger than a 1:3 mortar because there is a greater amount of solid fact in the former per bag of cement. The average block weighs 75 to 80 pounds or hollow so that a bag of cement mixed 1:4 will make 60 blocks while one mixed 1:3:5 will make 100 blocks. Knowing the quantity of mortar obtained from various mixtures and the exact weight of concrete in any type of block the number of blocks that can be made from 1 bag of cement is easily determined.

Blocks can be made by the wet or the dry process. A concrete thoroughly mixed to a plastic consistency is a stronger and more impervious than one mixed dry but a greater amount of labor is required since the blocks must set from 10 to 12 hours before they can be moved from molding to the rest of equipment and handling. The dry process is a great saving in dry mixing can be mixed or prepared sufficiently to keep the concrete from setting the block to be removed from the mold immediately and cured.



to storage where it can be cured. As cement requires a certain amount of moisture to develop crystallization and maximum strength sufficient water must be supplied during the curing process if it was not used at the time of mixing. As it is impracticable to use the necessary amount of water at the time of molding in the dry process the blocks must be watered just as soon as practical after molding without marring the blocks, usually 6 to 8 hours. The blocks should be stored under a shelter away from the wind and sun and sprayed with water frequently to keep them constantly moist for at least a week though 20 days is better. The temperature during the curing period should not be less than 50° F. Where the daily output is large enough to warrant the equipment the curing can be expedited by placing the blocks in a chamber containing steam saturated with moisture, for 48 hours and then cured at ordinary temperature for 8 days. The temperature of the steam chamber is maintained at from 100 to 130° F.

The concrete can be mixed by hand or machine. Machine mixing is the only economical method for commercial production and even when a comparatively small quantity of block are to be made a small mixer will save backaches.

The concrete after being mixed is placed in molds or forms of which there are many types available. An expensive mold or machine is not required. One may make his own forms, the simplest type of which is a bottomless box of a size depending upon the dimensions of the block, to be set upon a board or pallet. Hollow blocks can be formed by the use of removable cores made of stove pipe or wood. The hollows can be of any number, size, shape or arrangement, just so the walls or webs are from  $1\frac{1}{2}$  to  $2\frac{1}{2}$  inches thick. Even when a machine is used supplemental forms are necessary for making special blocks, sills etc.

Before purchasing a machine for commercial use it would be wise to see several types in operation. Nearly all the machines make an equally good block because the quality of the finished product is more dependent upon the materials and manner of handling than upon the machine while the speed of operation is determined by the skill of the operator. The machine should be guaranteed by a reliable manufacturer who will protect the purchaser in his rights since many of the machines and types of blocks are covered by patent. The territories in which they can be operated also may be restricted. If the exclusive right to operate a certain machine in a definite territory is purchased it does not prevent another person operating a different make of machine, for which he possibly may not have been required to pay a royalty, in the same area, therefore such rights are practically worthless. The only exclusive right of any value is a patent, applying to some good feature of the block itself, which may be attractive to intending purchasers.

Machines may be classified as: Vertical face or upright, face down, two piece block, and wet concrete machines. The first three types are used in the dry process. In the first type upright cores are employed to make the hollows and if desirable to have different mixtures in the face and body a vertical parting plate must be used. With this method there







is uncertainty that the facing will adhere to the body. In the second type, which is the more common, the face plate forms the bottom of the mold and when a facing is desired it is put into the form first and a weaker mixture rammed on top of it thus assuring a union between the two. The third type is adapted generally to pressure instead of tamping and is as a rule designed for large outputs. The fourth type requires a large number of molds as the concrete is poured mushy and must stay in the form until it sets firm enough to handle. The blocks made by this method are stronger and more impervious than those made by dry processes. This is a good method where only a few blocks are to be made at one time and permits of the use of homemade forms.

The different makes of machines vary as to method of applying power, handling the block and labor saving devices or other features for which the patent right is granted. After deciding upon the general type of machine best suited to the purpose that one should be selected which is simple, adapted to making fractions of blocks, easily moved (if this is a consideration) and with as few parts as possible.

When the building is to be stuccoed it is best to omit the facing and use a plain block which, if a little rough, provides a better key for the stucco. This is a very satisfactory manner of using the blocks, and one that should be more commonly followed as they make a good base for stucco which may be given one of several pleasing finishes. If the blocks are to show, the face should be treated as a finished concrete product. Concrete is too fine grained and too uniform in color for use in imitating natural stone with rock pitched face. Smooth or flat tooled surfaces are more suitable and can be produced by troweling the surface while soft with a wood float; the texture can be varied by using sand under the float or making small corrugations with a comb-like tool. If crushed granite or other selected aggregate is used in the facing mortar very good effects can be obtained by different treatments. After the block has hardened a little a very fine water spray, under about 40 lbs. pressure, directed against the face will wash away the cement coating and expose the aggregate. Or the cement coating can be etched off with a mixture of muriatic acid and water from 20 to 50 per cent in strength depending upon the age of the block; action of the acid can be stopped at any stage by applying plenty of water. At the right stage of hardness the surface can be brushed with a fibre or wire brush and when very hard the surface can be tooled or bush-hammered. Experience alone will determine the proper time to apply the treatments.

Coloring can be used in the facing mortar but the pigments should be the best of mineral matter preferably from the iron pigments. The exact amount to use for a shade is best determined by experiment. If used in too great a quantity the strength of the concrete or mortar will be lessened. The following will serve as a general guide: For blue use  $3\frac{1}{2}$  to 19 pounds ultramarine blue to a barrel (or four bags) of cement; buff, 5 to 15 lb. yellow ochre; brown, 25 lb. best roasted iron oxide or 6 to 20 lb. brown ochre; green, 23 lb. greenish blue ultramarine; gray, 2 lb. Germantown lampblack; red, 22 lb. raw iron oxide; bright red, 22 lb. Pompeian or English red; purple, 20 lb. Princes metallic; violet, 22 lb. violet oxide. Ultramarine is one of the best coloring materials.







Common lampblack or Venetian red are liable to fade or run. The sand, which should be dry, cement and pigment, should be thoroughly mixed before wetting. The color is considerably affected by different sands and somewhat by different brands of cement. White cement is frequently used to obtain light shades but is more expensive than the gray.

A block faced with a 1:2 Portland cement mortar is nearly waterproof and when properly cured will frequently answer without special treatment. No waterproofing scheme will strengthen the concrete while many methods damage the cement thus making the concrete less durable. However it is probably wise to use waterproofing at times. It can be used as a coating on the face of the finished block or incorporated in the mortar of either the facing or the body. It is occasionally used to advantage on the mortar for laying the blocks.

Many processes are employed and there are on the market various preparations designed for waterproofing concrete but before using any of them it would be wise to consult someone who has obtained results with the material or process under consideration. One authority claims that the following treatment was effective 12 years after application.

Dissolve one pound of concentrated lye and 5 pounds of alum in 2 gallons of water, care being taken that every particle is dissolved. Heating to near the boiling point will insure this without injury to the mixture. This constitutes the stock which may be made up in any quantity in the same proportions. To one pint of the stock add 10 pounds of cement thinning out with water until the mixture spreads well on the blocks or wall with a whitewash brush lathering freely and filling all pores in the surface. Usually 1 pint of the stock and 10 pounds of cement thoroughly mixed in a 12 quart pail with enough water to well fill the pail makes the wash about right. If the surface to be treated is dry it should be sprayed with water just before the wash is applied. The wash is best applied to blocks three or four days after they are cast and while they are being kept wet in curing. A few hours are sufficient for the wash to harden enough to stand a spray. The wash is not satisfactory for old work. Sometimes 1 part of this stock to 30 parts water is used in place of mixing water in making 1:2 mortar for the facing. This waterproofs the block and will leave the face free from brush marks.

The cost of manufacturing concrete blocks depends upon a number of factors the value of which depends upon local conditions. The local prices of materials and labor vary considerably and the skill and speed of the workmen and the layout of the plant have a very decided bearing on the cost. It may be said however that handmade blocks cost more than factory or machine made blocks. The following data may serve as a guide in determining the relative cost of homemade and commercial blocks.







100 hollow 8" x 8" x 16" blocks made of 1:3:4 concrete with a  $\frac{1}{2}$ " face of 1:2 mortar will require  $8\frac{1}{2}$  bags of cement,  $\frac{7}{8}$  cubic yards of sand, 1 cubic yard of gravel, the labor of 2 men for 6 hours. Knowing the local prices of the materials and the cost of factory made blocks delivered on the site one can readily decide whether it will pay to make the blocks by hand on the site. If the work can be done in spare time with no cash outlay except for the materials the advantage will probably be in favor of the homemade product.

As concrete blocks cannot be cut to fit an odd space or to make a bond without damage to the waterproofing skin it is well to prepare drawings showing every block in the building. The blocks may then be made the size and shape called for by the sketch which will also serve as a guide in placing them in the wall.

Blocks may be used for foundation or below ground walls but when interior dryness is desired the walls should be dampproofed on the exterior side in contact with earth. The first course of blocks should be laid upon a solid concrete footing.

Building ordinances specify the allowable thickness of walls in most cities but the following is considered good practice.

|                       |             |                         |
|-----------------------|-------------|-------------------------|
| For 1 story buildings | - - - - -   | 8" walls                |
| " 2 "                 | " - - - - - | 10" "                   |
| " 3 "                 | " - - - - - | 12" and 10" walls       |
| " 4 "                 | " - - - - - | 15", 12" and 10" walls. |

These thicknesses apply to walls carrying a span of 25 feet or less. If the walls carry a greater span or an unusually heavy load their thickness should be such that the load per square inch specified by local authorities is not exceeded. Some regulations permit party walls of blocks provided the hollows are filled with concrete as the wall is raised; others forbid their use in party walls.

A mortar composed of 1 part Portland cement, three parts sand and well slaked or hydrated lime (not in excess of 10% of the weight of the cement) is generally used for setting concrete blocks. Care should be taken not to mix more than can be used in 30 minutes as cement mortar cannot be retempered as can lime mortar. The blocks should be well wetted before laying to prevent drawing moisture from the mortar and are generally laid with  $\frac{1}{4}$ -inch joints. Various methods are used for supporting floor joists but the use of steel joist hangers is best. Whenever girders or joists rest upon walls so that there is a concentrated load on the blocks of over 2 tons, the blocks supporting the girders or joists must be made solid for at least 8 inches from the inside face. If the concentration is over 5 tons the blocks for at least 3 courses below and for a distance extending at least 18 inches each side of each girder shall be made solid for at least 8 inches from the inside







face. Whenever walls are decreased in thickness, the top course of the thicker wall shall afford full bearing for the webs and walls of the course of blocks above. Plugs should be built into walls for anchoring frames and other woodwork. Metal wall plugs are very convenient and not expensive. If freedom from dampness is desired the interior of exterior walls should be furred before the lath and plaster or other interior lining is applied. Furring is advisable in all first class construction.

The following is a partial list of manufacturers of concrete block machines.

American Hydraulic Stone Co., Denver, Colorado.  
 Concrete Construction Co., 3 Broad Street, New York, N. Y.  
 Ideal Concrete Machinery Co., South Bend, Indiana.  
 Miracle Pressed Stone Co., Minneapolis, Minn.  
 National Hollow Concrete Machine Co., Washington, D. C.  
 U. S. Cement Shingle Machinery Co., Saginaw, Michigan.  
 Universal Concrete Machinery Co., Norfolk, Virginia.  
 Sears Roebuck & Co., Chicago, Illinois.  
 Besser Manufacturing Co., Alpena, Michigan.  
 Ransome Concrete Machinery Co., Dunellen, New Jersey.

While these firms are believed to be reliable their mention should not be construed as an endorsement by the Department of Agriculture of either price or product.

The following periodicals frequently publish articles dealing with the manufacture and use of concrete block.

"Cement and Engineering News", 682 Transportation Bldg.,  
 Chicago, Illinois.  
 "Cement Era", The Cement Era Publishing Co., 538 So. Clark St.,  
 Chicago, Illinois.  
 "Cement World", Cement World Co., 1827 Prairie Ave., Chicago, Ill.  
 "Concrete-Cement Age", Cement Age Publishing Co., Detroit, Mich.  
 "National Builder", 540 So. Dearborn St., Chicago, Ill.  
 "American Carpenter and Builder", 1827 Prairie Ave., Chicago, Ill.

Drawings 2097 and 2098 accompany this Information Series.



These exterior walls are constructed in thickness, the top course of the thicker wall shall extend full height for the same and walls of the course of blocks above. Plans should be built to verify the accuracy of these and other dimensions. It is further recommended that the exterior walls should be turned before the last and placed in position. Interior finish is optional. Finishing is advisable in all cases where construction.

The following is a partial list of manufacturers of concrete block machines.

American Hydraulic Press Co., Denver, Colorado.  
Concrete Construction Co., 3 Third Street, New York, N. Y.  
East American Machine Co., South Bend, Indiana.  
Hawthorne Press Block Co., Minneapolis, Minn.  
National Relief Concrete Machine Co., Washington, D. C.  
U. S. Patent Concrete Machine Co., Saginaw, Michigan.  
National Concrete Machine Co., Norfolk, Virginia.  
Sears Roebuck & Co., Chicago, Illinois.  
Singer Manufacturing Co., Alpena, Michigan.  
Sawmire Concrete Machinery Co., Paterson, New Jersey.

While these firms are believed to be reliable their products should not be considered as an endorsement by the Department of Agriculture of either price or product.

The following periodicals frequently publish articles dealing with the manufacture and use of concrete blocks.

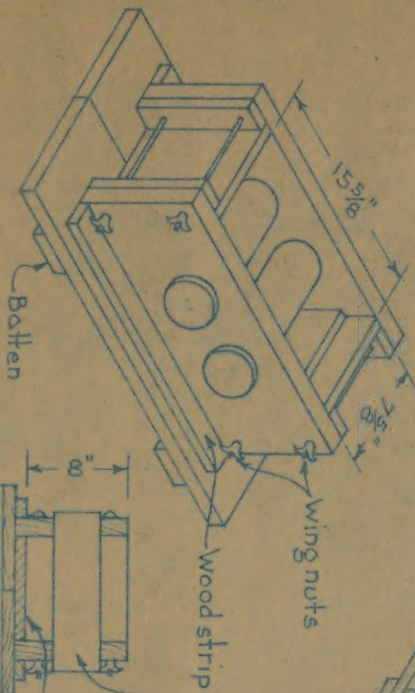
"Concrete and Reinforcing News", 522 Transportation Bldg., Chicago, Illinois.  
"Concrete Era", The Concrete Era Publishing Co., 522 So. Clark St., Chicago, Illinois.  
"Concrete World", Concrete World Co., 1837 Prairie Ave., Chicago, Ill.  
"Concrete-Concrete Age", Concrete Age Publishing Co., Detroit, Mich.  
"National Builder", 540 So. Dearborn St., Chicago, Ill.  
"American Carpenter and Builder", 1827 Prairie Ave., Chicago, Ill.

Drawings 3097 and 3098 accompany this information bullet.

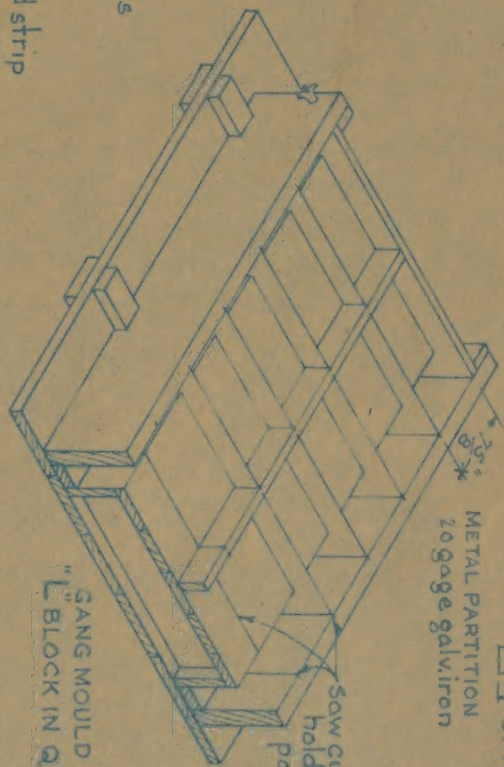
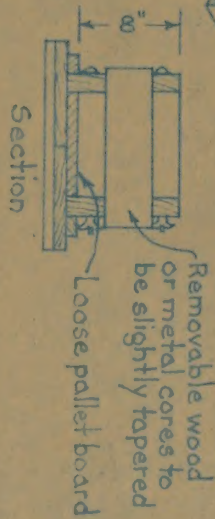




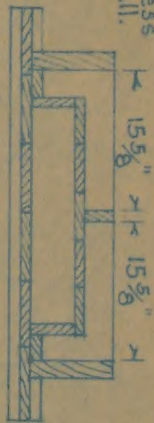
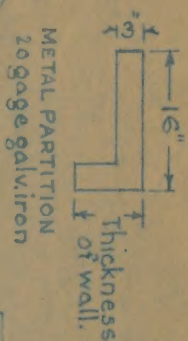
HOLLOW BLOCK



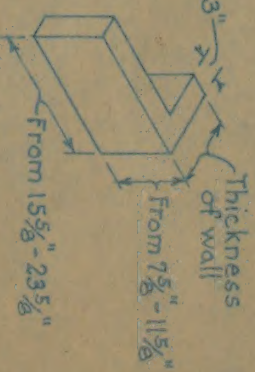
MOULD FOR MAKING  
HOLLOW BLOCK



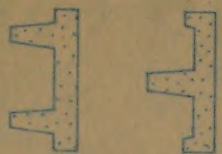
GANG MOULD FOR MAKING  
"L" BLOCK IN QUANTITIES



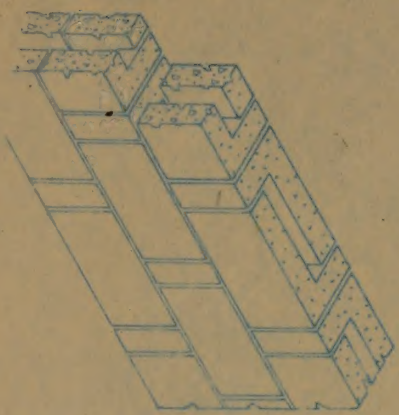
SECTION



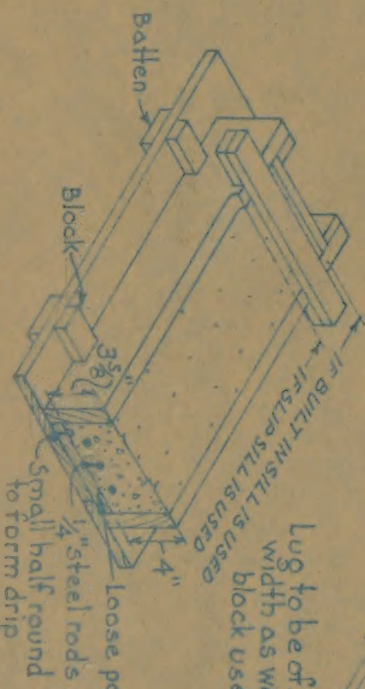
SIZE OF "L" BLOCK



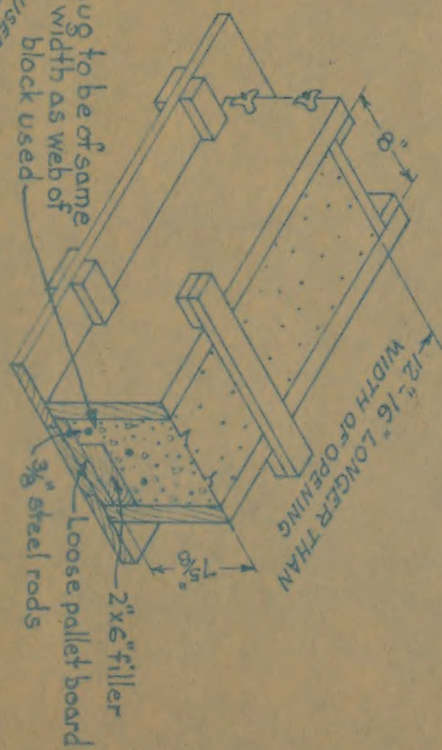
TWO PIECE  
BLOCK



WALL SECTION SHOWING  
METHOD OF LAYING BLOCKS  
TO OBTAIN BOND



MOULD FOR MAKING SILLS



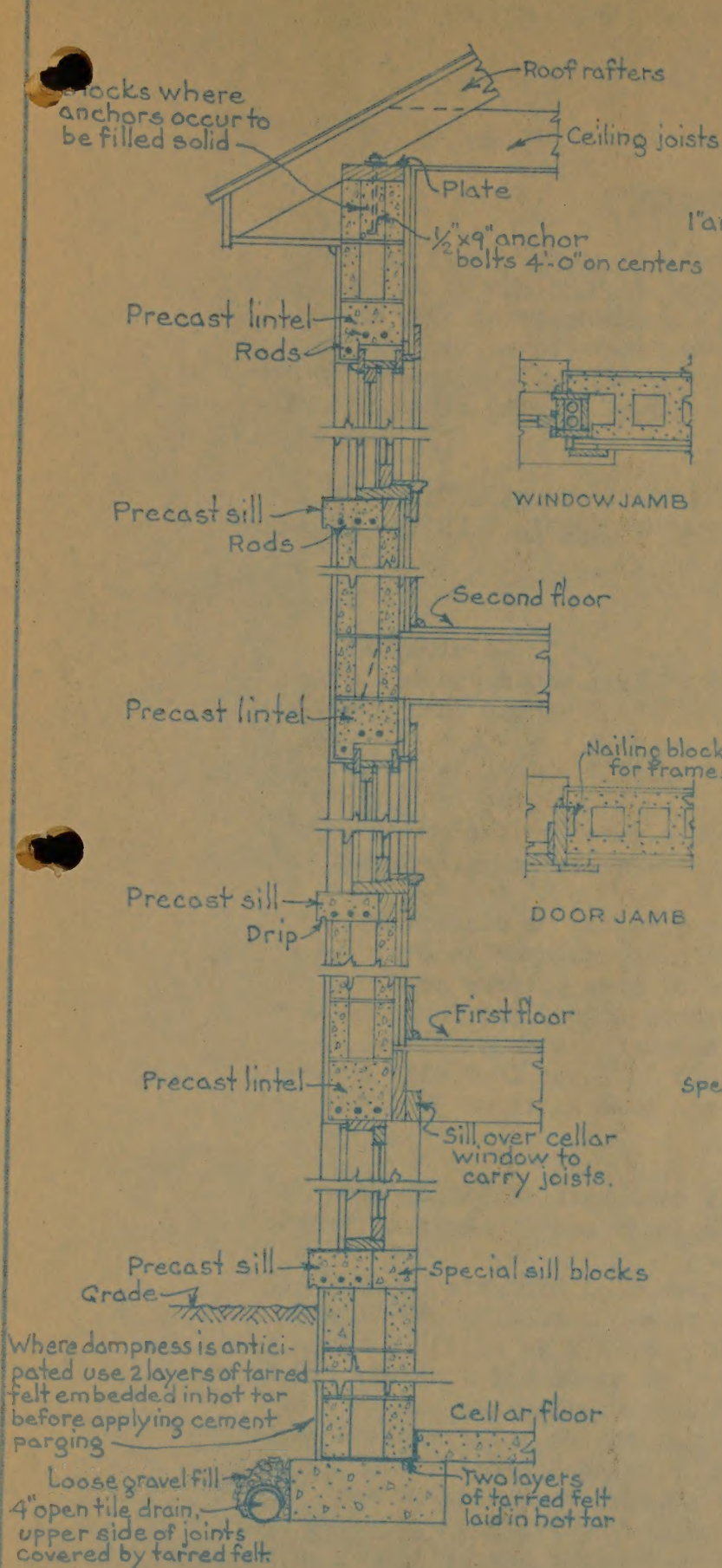
MOULD FOR MAKING LINTELS

|                                                          |                |                     |            |
|----------------------------------------------------------|----------------|---------------------|------------|
| U.S. DEPARTMENT OF AGRICULTURE<br>BUREAU OF PUBLIC ROADS |                |                     |            |
| DIVISION OF<br>AGRICULTURAL ENGINEERING                  |                |                     |            |
| CONCRETE BLOCK                                           |                |                     |            |
| Scale                                                    | Checked        | SHEET 1 OF 2 SHEETS | DESIGN NO. |
| Drawn by N.B.                                            | Traced by N.B. | REVISION NO.        | 2097       |
| Approved                                                 |                |                     |            |

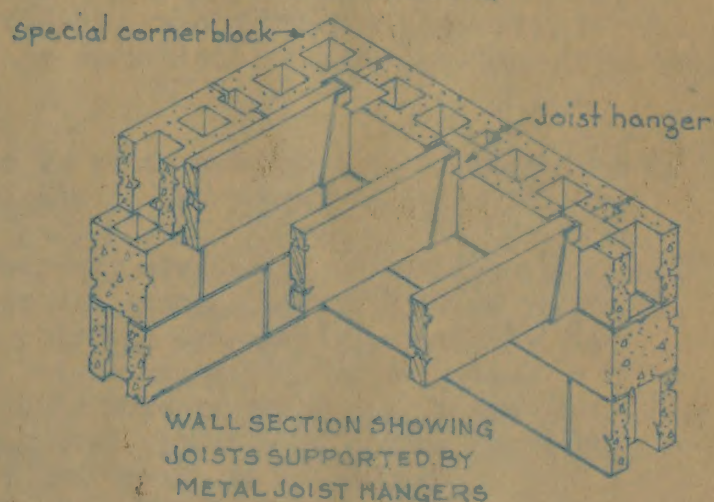
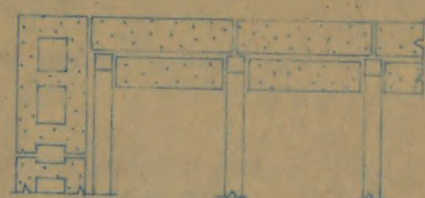
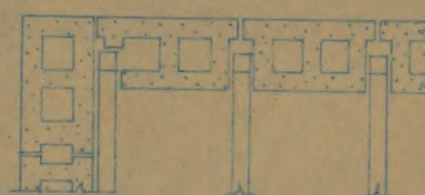
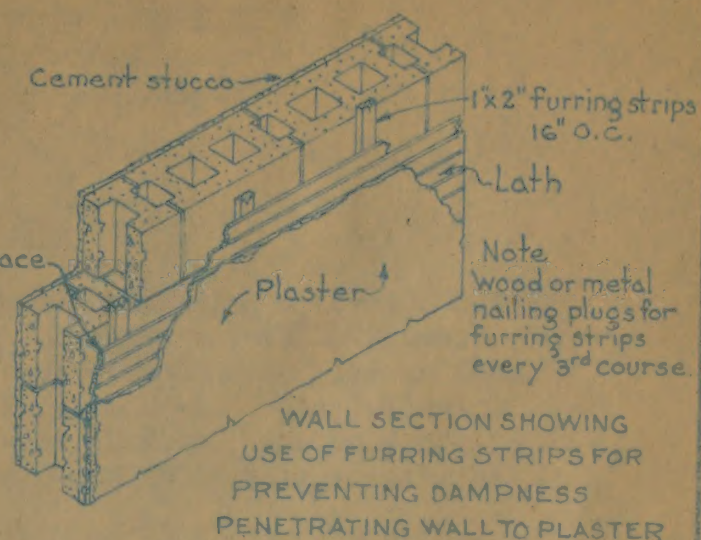








DETAIL WALL SECTION



|                                      |         |                     |            |
|--------------------------------------|---------|---------------------|------------|
| U.S. DEPARTMENT OF AGRICULTURE       |         |                     |            |
| BUREAU OF PUBLIC ROADS               |         |                     |            |
| DIVISION OF AGRICULTURAL ENGINEERING |         |                     |            |
| CONCRETE BLOCK                       |         |                     |            |
| Scale                                | CHECKED | SHEET 2 OF 2 SHEETS |            |
| Drawn by N.B.                        |         |                     |            |
| Traced by N.B.                       |         |                     |            |
| APPROVED                             |         | SUBJECT NO.         | SERIAL NO. |
|                                      |         | 605-G-2             | 2098       |







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 57

May, 1925.

POISONING TREES

Many inquiries come to the Department concerning a formula for a compound that can be employed in killing trees and sprouting stumps. The Department has made no experiments with such compounds and has no formula to recommend that is based on its own investigations. The following formulas and procedure, involving the use of arsenic, have been compiled from recommendations made by various agencies both in this country and in Australia.

IN USING THESE FORMULAS IT SHOULD BE REMEMBERED THAT ARSENIC IS A DEADLY POISON AND THAT CAUSTIC SODA IS INJURIOUS TO THE SKIN AND CLOTHING

Formulas:

| Formula 1                      | Formula 2                      |
|--------------------------------|--------------------------------|
| White powdered arsenic - 1 lb. | White powdered arsenic - 1 lb. |
| Washing soda (sal soda)- 3 "   | Caustic soda - - - - - 2 "     |
| Water - - - - - 4 gal.         | Water - - - - - 4 gal.         |
| Whiting - - - - - 1 lb.        | Whiting - - - - - 1 lb.        |

Either formula 1 or formula 2 may be used. Read over all of the directions for mixing, before starting.

Ordinary arsenic is not very soluble in water; therefore, soda, either in the form of washing (sal) soda or caustic soda, must be used to dissolve it. When washing soda is used 3 pounds are required for each pound of arsenic and boiling is necessary to bring about complete solution. Caustic soda, which is more expensive, need only be used in the proportion of 2 pounds of soda to 1 pound of arsenic, and the heat generated, if the necessary amount of water is used, is sufficient to make boiling unnecessary.

Mixing

The soda should be dissolved in water and the arsenic made into a paste, before combining these chemicals. The procedure is as follows:

- (1) The soda should be completely dissolved; if washing (sal) soda is used, one or two gallons of water are brought to the boiling point and the soda added a little at a time, stirring constantly. Caustic soda does not require that the water be hot to bring it into solution.
- (2) The arsenic paste should be made by adding, a little at a time, the dry, powdered arsenic to the required quantity of water. Care should be taken not to breathe the arsenic dust as it is poisonous.
- (3) The arsenic paste should then be added very slowly to the soda solution, stirring constantly, and being careful to stand away from the fumes so as not to inhale them since the fumes of arsenic are also very poisonous.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
DIVISION OF AGRICULTURAL ENGINEERING

May, 1922

Information Series No. 25

EXAMINING TESTS

Many industries now in the Department containing a formula for a compound that can be employed in killing insects and repelling insects. The Department has made an investigation with such compounds and has no formula to recommend that is based on its own investigation. The following formulae and procedures, involving the use of arsenic, have been compiled from communications made by various industries and in this country and is available.

It is being pointed out that it should be remembered that arsenic is a highly active and caustic substance and is injurious to the skin and clothing.

Examination:

| Formula 1                                | Formula 2                                |
|------------------------------------------|------------------------------------------|
| White arsenic (arsenic trioxide) - 1 lb. | White arsenic (arsenic trioxide) - 1 lb. |
| Boiling water (one gallon) - 1 gal.      | Boiling water - 1 gal.                   |
| Water - 1 gal.                           | Water - 1 gal.                           |
| Boiling - 1 hr.                          | Boiling - 1 hr.                          |

Either formula 1 or formula 2 may be used. Boil over all of the ingredients for 1 hour, before using.

Ordinary arsenic is not very soluble in water; therefore, when it is used in the form of boiling (all) water or arsenic water, must be used in solution. When washing with it must be done and repeated for each pound of arsenic and boiling is necessary to insure complete solution. Arsenic water, which is not arsenic, must only be used in the proportion of 1 pound of arsenic to 1 gallon of water, and the same procedure. It is necessary to use a large amount of water in order to make boiling unnecessary.

Warning:

The water should be allowed to settle in water and the arsenic water into a pan, before combining these chemicals. The procedure is as follows:

- (1) The water should be completely dissolved; it should be used in the form of boiling (all) water and the arsenic water should be added to the boiling water and the water should be added to the boiling water. Arsenic water does not require that the water be not so high as to be boiling.
- (2) The arsenic water should be added by adding a little at a time. The arsenic water should be added to the boiling water of water. The arsenic water should be added to the boiling water of water. The arsenic water should be added to the boiling water of water.
- (3) The arsenic water should be added to the boiling water of water. The arsenic water should be added to the boiling water of water. The arsenic water should be added to the boiling water of water.
- (4) The arsenic water should be added to the boiling water of water. The arsenic water should be added to the boiling water of water. The arsenic water should be added to the boiling water of water.



(4) When both the arsenic paste and the soda are dissolved and chemically combined - which requires from 20 to 40 minutes and can be determined by the mixture becoming clear - add the balance of the 4 gallons of water, and then the whiting. The whiting serves as an indicator on the trees treated, as it turns white on drying and thus shows which trees have been poisoned.

#### Applying the Poison

To apply the preparation, cut a continuous row of shallow gashes, penetrating just into the sapwood, around the trunk of the tree and as close to the ground level as it is convenient to work. Make the cuts so that they will retain the poison instead of permitting it to run down the trunk. Pour the solution into the cuts, using an old tea-kettle or coffee-pot with a long spout for convenience in applying. Since the whiting has a tendency to settle to the bottom, the mixture should be constantly shaken up while pouring.

The time for poisoning is when the tree is dormant; that is, when the sap movement is at its minimum and the sap is down in the roots and lower portions of the trunk. This occurs in winter. The main object in applying the treatment at this time is to prevent the growth of suckers. Trees can be killed by poisoning or ring-barking at practically any season but to prevent the growth of suckers it is highly important to operate when the sap is down or just completing its downward course.

The species of trees which are said to be most susceptible to poison are the hardwoods, including elms, maples, oaks, locusts and ash. Gums, persimmons, hickories, pines and cottonwoods are less susceptible.

It is advisable not to turn stock into a field where the poison has been used until several days have elapsed after the treatment.

#### Preserving the Mixture.

The compound will keep indefinitely in an air-tight container and for some time in the open. It should never be left where children or stock can get at it nor should vessels which have contained the poison be employed for any other purpose. The containers in which the mixture is stored should be labeled "POISON". Empty containers should be destroyed.

#### Stumps.

Whatever success may be had in hastening the decay of trees by the use of poison is due to the fact that the poison is introduced into the circulatory sap system of the tree and by it distributed to every part. This results in almost immediate death of the tree and the breaking down of all its defences against decay and the ravages of insects, not only in the tree and all its branches but in the entire root system as well.



(4) When both the aromatic parts and the ends are dissolved and immediately combined - which requires from 20 to 30 minutes and can be facilitated by the addition of a small amount of water - and the balance of the solution of water, and then the mixture. The mixture should be kept in a container as the time passes, as it turns white on drying and thus shows which there have been polymerized.

### Examination of the Polymer

To apply the preparation, add a small amount of the solution to the polymerizing liquid in the apparatus, around the neck of the flask and as shown in the figure. It is important to note that the solution should be added slowly, the polymer being formed at the neck of the flask. From the solution that the water, which is all the water of solution, is added to the polymer. The mixture should be kept in a container as the time passes, as it turns white on drying and thus shows which there have been polymerized.

The time for polymerizing is when the time is known; that is, when the polymerizing is at the minimum and the time is known in the flask and in the neck of the flask. This should be noted. The main object is to prevent the formation of the polymer at the neck of the flask. This can be done by preventing the growth of the polymer. This can be done by preventing the growth of the polymer. This can be done by preventing the growth of the polymer. This can be done by preventing the growth of the polymer.

The specimen of resin which are said to be most susceptible to polymerization are the aromatic, including ethyl, methyl, isopropyl, and n-butyl. These are the aromatic, including ethyl, methyl, isopropyl, and n-butyl. These are the aromatic, including ethyl, methyl, isopropyl, and n-butyl.

It is noticeable that in some cases a little more of the polymer has been used than the amount of the monomer.

### Examination of the Mixture

The compound will be polymerized in an air-tight container and for some time in the open. It should be noted that the polymer is formed at the neck of the flask. This can be done by preventing the growth of the polymer. This can be done by preventing the growth of the polymer. This can be done by preventing the growth of the polymer.

### Summary

Whatever monomer may be used in preparing the resin of resin by the use of polymer is that in the flask and the neck of the flask. This can be done by preventing the growth of the polymer. This can be done by preventing the growth of the polymer. This can be done by preventing the growth of the polymer.



BECAUSE NEITHER GREEN, SUCKERED NOR DEAD STUMPS HAVE A GENERAL SAP CIRCULATING SYSTEM THE USE OF POISON ON STUMPS HAS NO APPRECIABLE EFFECT IN HASTENING THEIR DECAY.

Quantity and Cost

The quantity of the solution to use depends upon the size of the trees. For trees 4 feet in diameter about one quart of the solution is said to be required.

The following cost of poisoning has been reported. The materials were purchased from wholesale dealers in large quantities, the sal-soda at 5¢ per pound and white arsenic at 12¢ per pound. On one large tract the average cost of the poison was 35 cents per acre and the minimum cost 24 cents. The cost of applying the poison in this case was \$1.50 per acre, the wages of labor being \$1.50 per day.



THESE RESULTS SHOW THAT THE RATE OF GROWTH OF THE  
CULTURE IS NOT AFFECTED BY THE PRESENCE OF THE  
SUBSTRATE IN THE MEDIUM.

### DISCUSSION

The results of the present investigation show that the  
rate of growth of the culture is not affected by the  
presence of the substrate in the medium.

The following table shows the results of the  
present investigation. The rate of growth of the  
culture is not affected by the presence of the  
substrate in the medium. The rate of growth of  
the culture is not affected by the presence of the  
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the culture is not affected by the presence of the  
substrate in the medium.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 58.

June, 1925

Concrete Fence Posts

Fence posts that are servicable and satisfactory can be made of concrete but their durability depends upon the use of good materials handled in the proper manner and upon correct design.

The first cost of concrete fence posts may be more or less than that of the best wooden posts, depending upon the local timber supply, availability of sand and gravel and the skill of the labor employed.

Failure is almost sure to result if the essentials of construction are not observed, because, to make a good post requires more care and skill than almost any other object made of concrete. However, the requirements are not complex, in fact they are simple, but must be met.

Size of Post.

Variously shaped posts are made but those with an approximately square or round crosssection are the strongest for the materials used. Corner and brace posts, because of their weight, are usually cast in place while line posts are precast or moulded. The weight of the latter is decreased by tapering two sides and considerably lightened by tapering the four sides. The crosssectional area and length of a post will depend upon the purpose for which it is to be used.

The common length of a line post is 7 feet, while the top crosssection varies from 3" x 3" to 6" x 6" and the bottom crosssection from 5" x 5" to 6" x 6". When a post longer than 7 feet is needed it is advisable not to reduce the dimensions of the top but to enlarge the butt to dimensions as established by extending the slope of the sides. So far no definite way has been found to determine just how large or strong a post should be but tests and experience have shown that a 7 foot post, 3" x 3" at the top and 5" x 5" at the butt is amply strong for a line post, if reinforced with one 1/4 inch square rod in each corner.

Reinforcement.

A satisfactory type of rod for the reinforcement is a 1/4 inch square steel rod but the 1/4 inch round rod is more commonly used because it can be obtained from local dealers and it has sufficient strength for the purpose. Steel wire, varying in size from No. 3 to No. 12 gage, has been successfully employed as reinforcement but the smaller gages require that several strands be twisted together. Two No. 12 gage wire approximate in area one No. 3, about 1/4 inch diameter. The reinforcement should not be galvanized but must be free from grease and loose rust. Barbed wire is not suitable for reinforcement nor is the heavy gage wire which has been coiled because the strain of straightening weakens the wire; wire for reinforcement should be purchased in bundles of loose strands cut to the proper length. It is advisable to provide rods 3 inches longer than the post to permit of bending hooks on the ends for increasing the bond.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF ENTOMOLOGY  
DIVISION OF ENTOMOLOGICAL ENGINEERING

Information Requested by \_\_\_\_\_

Reference is made to \_\_\_\_\_

It is requested that you advise the Bureau of Entomology and Plant Quarantine as to the availability of the material requested in the above information request.

The first item of information requested is the availability of the material requested in the above information request.

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Spacers of No. 10 gage wire (baling wire will serve) are used to keep the corner rods in just the right position so that they will perform their function of resisting tensile stresses and be protected from corrosion. There should be at least three rows (6 spacers) in the length of the post. The spacers can be made by wrapping No. 10 wire around spikes, of a diameter equal to that of the corner rod, (driven into a heavy board or table top) so as to form a series of loops thus -

$\frac{3}{4}"$  a  $1\frac{1}{2}"$  a  $\frac{3}{4}"$  The length "A" is the dimension of the post  
 0 0 0 0  
 at the section for which the spacer is intended minus  $1\frac{1}{2}$  inches. After removing the loops from the spikes, they are cut apart by clipping, the  $1\frac{1}{2}$  inch length, so as to leave  $\frac{3}{4}$  inch beyond each eye thus  $\frac{3}{4}"$  a  $\frac{3}{4}"$   
 0 0

Where line posts will be subjected to pressure from stock, as when used in fences around corrals, it is advisable to make them with a greater crosssection than regular line posts and to add four short extra rods long enough to extend up 4 feet from the butt.

#### Concrete Materials.

Portland cement of a standard brand should be used. The sand and gravel should be clean and of varying size of particles; the sand from fine to  $\frac{1}{4}$  inch with the coarser particles predominating, dust being eliminated; the gravel from  $\frac{1}{4}$  to  $\frac{3}{4}$  inch though  $\frac{1}{2}$  inch gravel should be the limit when the post has a thin section. A fairly rich mixture should be used in the making of concrete fence posts, such as; 1:1 $\frac{1}{2}$ :3 or 1:2:3. Sometimes a 1:3 mortar is used but this is not as economical a mixture. A 1:2:4 mixture produces a good concrete for making corner posts over 6" x 6" in area when cast in place.

The consistency should be soft enough to permit the concrete to settle readily in the forms.

Farmers' Bulletin No. 1279\*, "Plain Concrete for Farm Use," describes the qualities of concrete ingredients, their selection and methods of handling also the care of the finished product.

#### Molds.

Molds are made from both wood and metal and are built for single posts or in "sets" or "gangs." Commercial metal forms can be purchased but in making a selection choose a type that is simple to operate, strong and of such a shape that the reinforcement can be readily placed in its proper location. Metal forms are lighter to handle and make a neater looking post than wooden ones. When a large number of posts are to be made it may be economical to purchase a commercial form. Wooden forms for rectangular posts can be readily made somewhat as illustrated, Figure 1. The lumber should be dressed if neat appearing posts are wanted.

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\* A copy may be obtained from the Office of Publications, Department of Agriculture, Washington, D. C.







The forms should be greased before each filling with crude oil or soap to prevent the concrete adhering to them and should be cleaned and freed from concrete immediately after removing the posts. Wooden forms should be thoroughly wetted before filling to prevent water in the concrete swelling the lumber and thus cracking the post.

#### Casting the Post.

After the forms have been set securely or conveniently located they should be greased, then a  $3/4$ " to 1" depth of concrete spread evenly over the bottom; two of the reinforcing rods separated by spacers placed and the forms filled with concrete to within  $3/4$  to 1 inch of the top; next the second pair of rods with spacers are placed and the forms filled with concrete. The concrete should be well compacted by jolting the forms or tamping. If desired the exposed corners of the posts may be beveled with an "edger" and the open face given a neat finish by troweling.

#### Curing.

The quality of the post is determined, to a large extent, by the curing it receives. The green post must be left in the form until thoroughly hardened, usually two or three days depending upon the weather. The sides and ends of the mold may then be removed for use on another platform but the posts should stay on their bottom board in the shade away from wind and be kept moist by covering with straw or by wetting with water for at least a week.

The posts, if handled with care, may be stored on end against an unyielding support or piled as are wooden posts to season for 28 days, though it is a good plan to allow them to season two or three months, if time permits, since concrete gains considerable strength for the first year. A jar, before the post has gained its full strength, in handling or hauling might seriously damage it.

To avoid delay, caused by permitting the post to cure in the molds, it is advisable to provide extra pallets or false bottoms for the forms. Thus the sides can be removed as soon as the concrete has become firm and the post can be lifted out on the pallet with less risk of breakage and allowed to cure on them.

#### Materials Required.

The materials required for different sizes of posts can be determined by figuring the volume of the post in cubic feet and with the aid of Table I in Farmers' Bulletin No. 1279 the amount of cement, sand and gravel can be estimated for various mixtures of concrete.

The following tables will be helpful for estimating the materials required for the sizes of posts indicated made of 1:3 or 1: $1\frac{1}{2}$ :3 mixtures:



The first section of the report is devoted to a general survey of the situation in the country. It is followed by a detailed account of the events of the past few days, and concludes with a summary of the results of the investigation.

The second section of the report is devoted to a detailed account of the events of the past few days. It is followed by a summary of the results of the investigation.

The third section of the report is devoted to a detailed account of the events of the past few days. It is followed by a summary of the results of the investigation.

The fourth section of the report is devoted to a detailed account of the events of the past few days. It is followed by a summary of the results of the investigation.

The fifth section of the report is devoted to a detailed account of the events of the past few days. It is followed by a summary of the results of the investigation.

Signed: \_\_\_\_\_

The sixth section of the report is devoted to a detailed account of the events of the past few days. It is followed by a summary of the results of the investigation.

The seventh section of the report is devoted to a detailed account of the events of the past few days. It is followed by a summary of the results of the investigation.



## DATA FOR SINGLE POSTS

| No. | Length | Top       | Butt    | Cu. Ft. | Lbs.  | Number<br>Cu. Yd.<br>Concrete |
|-----|--------|-----------|---------|---------|-------|-------------------------------|
| 1   | 7'-0"  | 3" x 4"   | 5" x 4" | .730    | 109.5 | 36.9                          |
| 2   | 7'-6"  | 3" x 4"   | 5" x 4" | .802    | 120.3 | 33.6                          |
| 3   | 7'-0"  | 3" x 3"   | 5" x 5" | .814    | 122.1 | 33.1                          |
| 4   | 8'-0"  | 3" x 4"   | 5" x 4" | .874    | 131.1 | 30.8                          |
| 5   | 7'-0"  | 3½" x 3½" | 5" x 5" | .896    | 134.4 | 30.1                          |
| 6   | 7'-0"  | 4" x 4"   | 6" x 4" | .925    | 138.7 | 29.1                          |
| 7   | 7'-6"  | 4" x 4"   | 6" x 4" | .991    | 148.6 | 27.2                          |
| 8   | 8'-0"  | 4" x 4"   | 6" x 4" | 1.057   | 158.5 | 25.5                          |
| 9   | 7'-0"  | 5" x 5"   | 5" x 5" | 1.203   | 180.4 | 22.4                          |

## MATERIALS FOR 100 POSTS

| No. | C. Y.     | 1:3 Mix | 1:1½:3 Mix | Wt. of  | Wt. of |         |           |              |
|-----|-----------|---------|------------|---------|--------|---------|-----------|--------------|
|     | Concrete  | Sacks   | C.Y.       | Sacks   | C.Y.   | C.Y.    | ¼" round  | No. 10       |
|     | :100 post | :cement | : sand     | :cement | : sand | :gravel | :rods-lb. | :spacers-lb. |
| 1   | 2.7       | 28.0    | 3.13       | 20.6    | 1.13   | 2.30    | 483       | 14.5         |
| 2   | 2.96      | 30.8    | 3.43       | 22.6    | 1.23   | 2.52    | 517       | 14.5         |
| 3   | 3.01      | 31.3    | 3.49       | 23.7    | 1.26   | 2.56    | 483       | 14.5         |
| 4   | 3.23      | 33.6    | 3.75       | 24.8    | 1.36   | 2.74    | 550       | 14.5         |
| 5   | 3.32      | 34.5    | 3.85       | 25.4    | 1.39   | 2.82    | 483       | 15.5         |
| 6   | 3.42      | 35.6    | 3.97       | 26.1    | 1.44   | 2.90    | 483       | 14.5         |
| 7   | 3.66      | 38.1    | 4.25       | 28.0    | 1.54   | 3.11    | 517       | 14.5         |
| 8   | 3.91      | 40.7    | 4.54       | 29.9    | 1.64   | 3.23    | 550       | 14.5         |
| 9   | 4.45      | 46.3    | 5.16       | 34.0    | 1.87   | 3.76    | 966       | 19.4         |

Post 9 has 8 rods 7'3",  
1/2 inch bevel on each corner of posts.







The following will be of assistance in estimating the quantity of wire needed for posts:

|                                                  |              |            |
|--------------------------------------------------|--------------|------------|
| 1 lb. of $\frac{1}{4}$ " round reinforcing steel | contains 6   | lin. ft.   |
| 1 lb. of $\frac{1}{4}$ " square " " "            | 4.71         | " "        |
| 1 lb. of No. 3 gage wire                         | contains 6.3 | lin. feet. |
| 1 lb. of " 10 " " "                              | 20.57        | " "        |
| 1 lb. of " 12 " " "                              | 33.69        | " "        |

To estimate the amount of No. 10 gage wire needed for one spacer allow 1 inch more than the dimension of the post for each rod at the section for which the spacer is intended.

#### Labor and Cost of Making.

The cost of making posts will vary widely with the conveniences and equipment available for mixing and handling the material. Five to ten posts per hour for each worker is an average rate of production but with special factory equipment the production may be materially increased. Local prices of material on the site should be obtained.

Assuming average prices near markets the cost of posts given in the table can be ascertained thus: - consider post No. 3 - - 100 of these posts will cost as follows:

|                                                                             |          |
|-----------------------------------------------------------------------------|----------|
| 23.7 sacks of cement at \$.70 per sack - - - - -                            | -\$16.59 |
| 1.26 cu. yd. sand at \$1.50 per cu. yd. - - - - -                           | 1.89     |
| 2.56 " " gravel at \$2.00 " " - - - - -                                     | 5.12     |
| 483 lb. $\frac{1}{4}$ " round rods at \$.04 $\frac{1}{2}$ per lb. - - - - - | 21.74    |
| 14.5 lb. No. 10 wire at \$.05 per lb. - - - - -                             | .73      |
| 20 man hours at 5 posts per hour \$.50 per hr. - - -                        | 10.00    |
| Total - 100 posts - - -                                                     | -\$56.07 |

The cost of one post will be approximately 57 cents.

The cost of molds should be considered but this amounts to a small proportion of the cost of one post since, if properly cared for, they will serve for a large number of posts. The actual cash outlay can be reduced if local gravel is obtainable, if baling wire is available for spacers and if spare labor is utilized. While the cost is not lowered by these considerations yet the reduction in cash outlay will make posts available for \$17.74 less per hundred or for 39 cents apiece.

#### Setting Posts.

If a post is not square it should be placed in setting so that the narrow side will support the wire fencing. The character of the soil determines the necessary depth of setting, usually from 1 $\frac{1}{2}$  to 2-2/3 feet, the earth should be thoroughly tamped around the post. On account of the care required in handling it is not possible, in a day, to set as many concrete as wood or metal posts and this fact should be considered in estimating their cost.



The following table shows the results of the survey of the ...

|     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

The results of the survey of the ...

Table showing the results of the survey of the ...

The results of the survey of the ...

The results of the survey of the ...

|     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

The results of the survey of the ...

The results of the survey of the ...

Table showing the results of the survey of the ...

The results of the survey of the ...



There are numerous methods used for fastening the fencing to concrete posts. The methods shown in Figure 2 have proven satisfactory and have the advantage over others which require holes or grooves in the posts, as do bolts, strips of wood and porous concrete inserts, in that the post is not weakened. If any of the last-named methods are employed the crosssection of the post should be increased, thus adding to the cost and difficulty of handling.

#### Corner, Gate and Brace Posts.

Concrete posts at corners of fences and entrances must be strong and well braced to resist the strain coming upon them from stretching the wire and to bear the weight of a gate.

These may be cast in place with the necessary braces, or pre-cast and set with a derrick and then braced. On account of their size and weight they are usually cast in place. The concrete should be mixed in the proportions as described on page 3 and properly cured. Fencing or gates should not be fastened to the posts until they are 28 days old. The attached illustrations show two types of corner posts and simple forms.

Braces should be placed in line with the fence so that they will bear against the post at a point not more than  $2/3$  of the distance above the ground to the top of the post. They must be reinforced the same as posts, the amount required depending upon their length, size and design. Four  $1/4$  or  $3/8$  inch round rods should be used.

#### Posts for Vineyards.

The fence posts described have given satisfaction for supporting grape vines. Generally a post 4" x 4" at the top and 6" x 4" at the bottom is used. Sometimes a groove is made, in casting the post, at the location of horizontal wires to provide additional support for the arbor wires so that the weight of the vines will not slide them down the post. Braced posts are required at the ends of the rows.

#### Manufacturers of Molds.

Following is a partial list of firms which manufacture concrete post forms:

D and A Post Mold Co., Three Rivers, Mich.  
 Milwaukee Post Mold Co., Milwaukee, Wis.  
 Kimballton Construction Co., Atlantic, Iowa.  
 Ohio Post Mold Company, 622 Madison Ave., Toledo, Ohio.  
 National Concrete Machinery Co., Madison, Wis.  
 Hotchkiss Lock Metal Form Co., Binghampton, N. Y.  
 Raber and Lang, Kondallville, Indiana.  
 E. L. Miller Manufacturing Co., 22 W. 33rd St., Kansas City, Mo.  
 Permanent Products Co., 140 S. Dearborn St., Chicago, Ill.  
 Concrete Equipment Company, Holland, Mich.



1880

1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 25

... ..

*[Faint handwritten notes at the bottom of the page]*



While these firms are believed to be reliable it should not be assumed that their mention implies any particular endorsement by the Department of either the prices or quality of their products.

The following bulletins, most of which are available only at libraries of the larger cities or of State Agricultural Colleges, deal with the making of concrete posts and are listed for the information of those who wish to investigate the subject in more detail.

- Farmers' Bulletin 384, Article on page 29.  
 " " 403, "Construction of Concrete Fence Posts."  
 Colorado Station Bulletin 148, "Cement and Concrete Fence Posts."  
 " " 161, "Materials Used in Constructing  
 Cement and Concrete Fence Posts."  
 Iowa Station Bulletin 219, "Concrete Fence Posts."  
 Wisconsin Station Circular of Information, No. 5, "The Hollow  
 Concrete Fence Post."  
 American Ry. Eng. Assoc. Bull., Vol. 25, No. 257, July, 1923.  
 Good, explicit specifications and drawings for  
 making square and round fence posts; includes  
 especially grading sizes for aggregate.

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 The Following Books Contain Articles on Concrete Fence Posts.

- "Concrete Construction for Rural Communities."  
 by Roy A. Seaton - McGraw-Hill Book Company.  
 "Engineering on the Farm," by J. T. Stewart. Rand McNally & Co.  
 "Equipment for the Farm and the Farmstead."  
 by Harry C. Ramsower, - Ginn & Company.  
 "Farm Engineering, Vol. 1, Farm Mechanics," Pages 304-307.  
 by Robb and Behrends. - John Wiley and Sons

-----  
 The Following References have Appeared in Periodicals:

- Wallaces Farmer, May 19, 1916, page 11, "Making Concrete Fence Posts."  
 Dakota Farmer, Sept. 15, 1915, page 912, "Fencing Problems."  
 Iowa Homestead, Apr. 13, 1916, page 16, "Concrete Posts Everlasting."  
 Nov. 18, 1915, page 11, "Posts Made of Concrete."  
 Country Gentleman, Oct. 21, 1916, page 17, "Concrete & Gate Posts."  
 Nov. 25, 1916, "Concrete Gate or Fence Posts."  
 May 6, 1916, "Cost of Concrete Posts."  
 March 25, 1916, "Concrete Fence Posts."  
 Jr. Dept. Agri. Victoria 19, 623-40'21, "Making Concrete Floors  
 and Posts."  
 Better Fruit 17; 708. No. 23, "Dressing up the Vineyard." (Concrete  
 posts."  
 Agri. Gaz. N. SW. 20, (1909) No. 4, p. 314, "Concrete Posts."  
 Concrete Engineering, July 1908, p. 189, Contains an article de-  
 scribing concrete telegraph poles 20-28 ft. high.







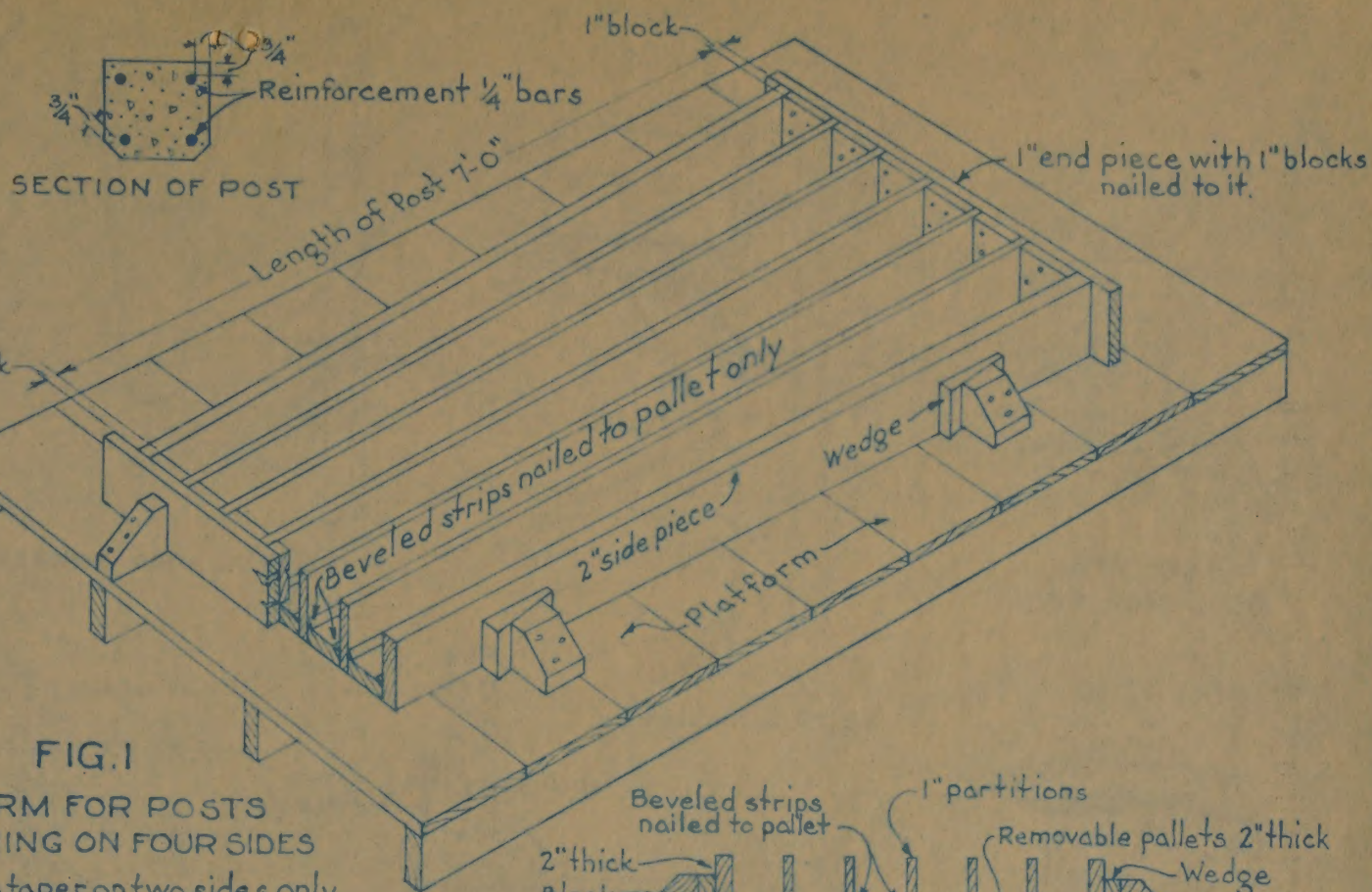
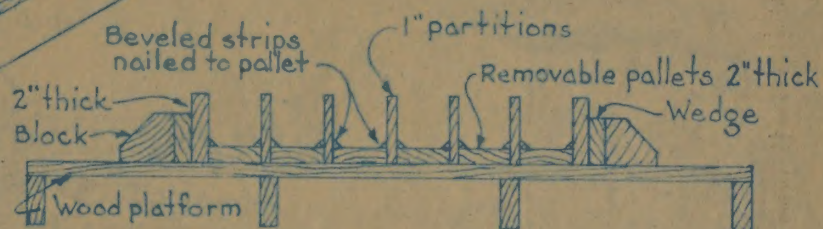


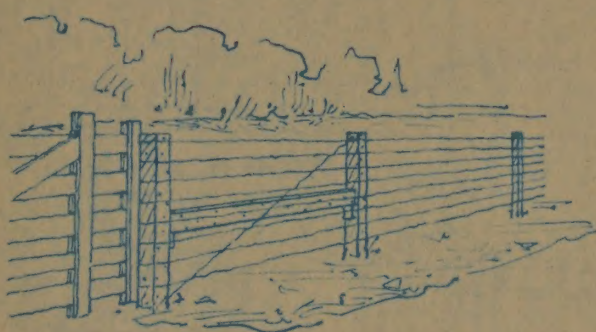
FIG. 1

# FORM FOR POSTS TAPERING ON FOUR SIDES

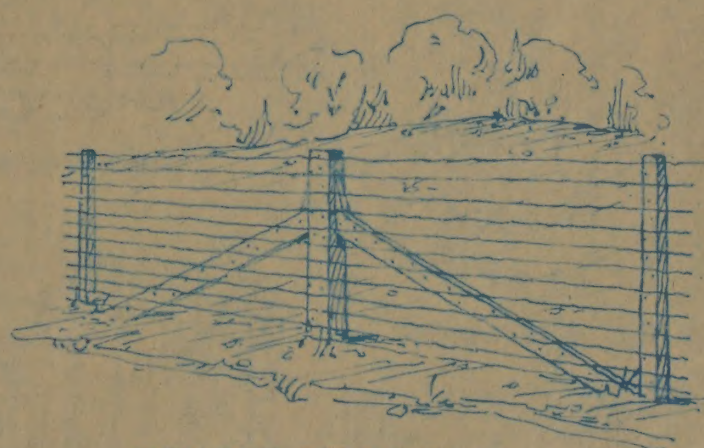
If posts taper on two sides only,  
the partitions are the same width  
throughout their length instead  
of tapering as shown



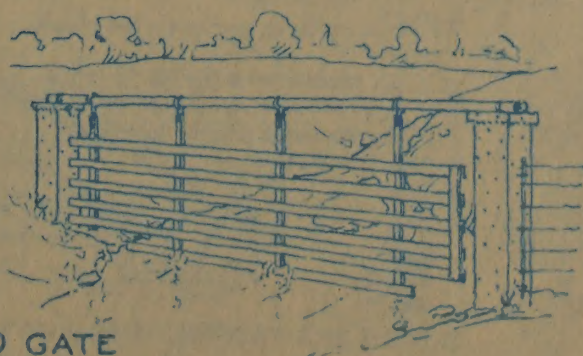
SECTION OF FORM



BRACED GATE POST



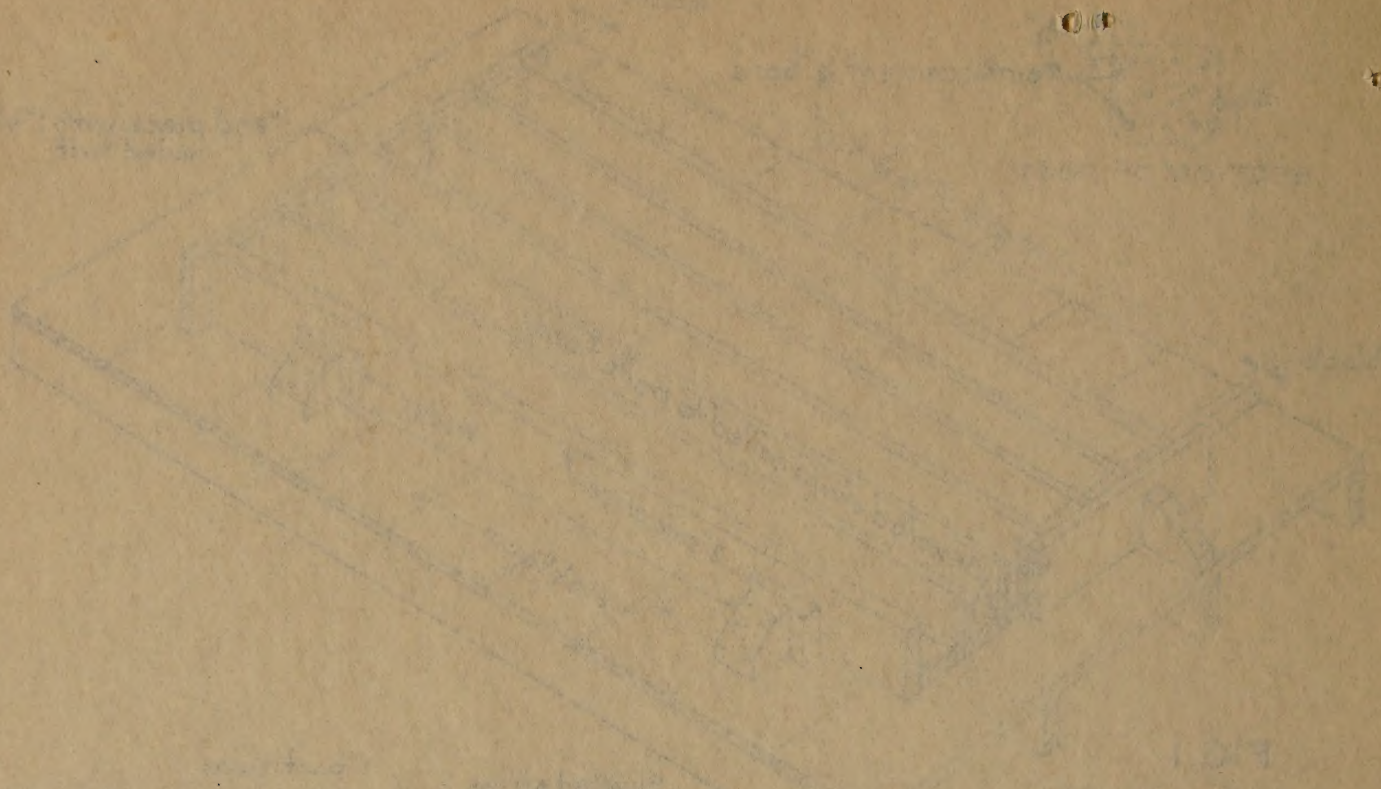
BRACED FENCE POST



FLOOD GATE

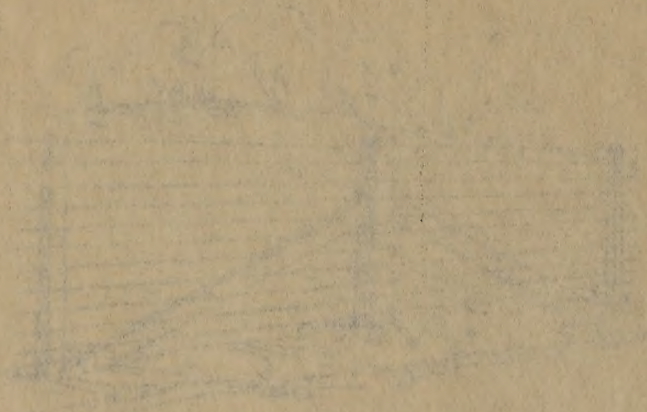
|                                      |         |                     |            |
|--------------------------------------|---------|---------------------|------------|
| U.S. DEPARTMENT OF AGRICULTURE       |         |                     |            |
| BUREAU OF PUBLIC ROADS               |         |                     |            |
| DIVISION OF AGRICULTURAL ENGINEERING |         |                     |            |
| CONCRETE POSTS                       |         |                     |            |
| Scale                                | CHECKED | SHEET 1 OF 2 SHEETS |            |
| Drawn by                             |         | SUBJECT             | SERIAL NO. |
| Traced by N.B.                       |         | 698A                | 2116       |
| APPROVED                             |         |                     |            |



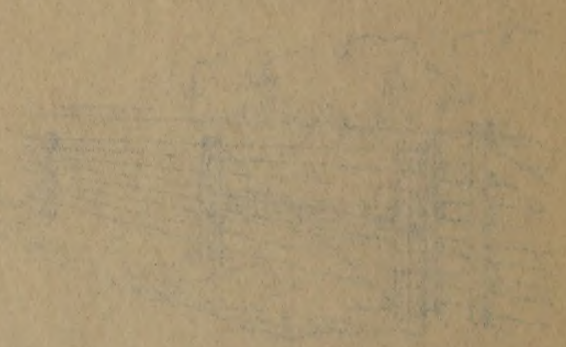


FORM 1 ON POSTS  
TAKING ON FOR 4000  
The structure is shown in a perspective view, with the top surface divided into a grid of squares. The structure is supported by a series of vertical posts. The drawing is very faint and appears to be a technical sketch or a blueprint.

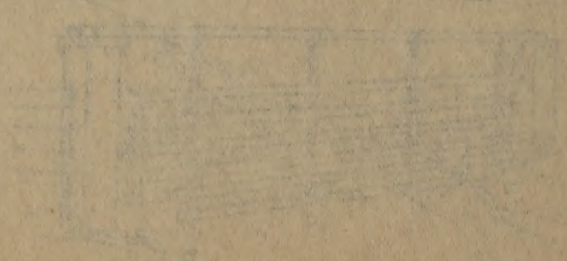
SECTION OF FORM



BRACKET FOR POST



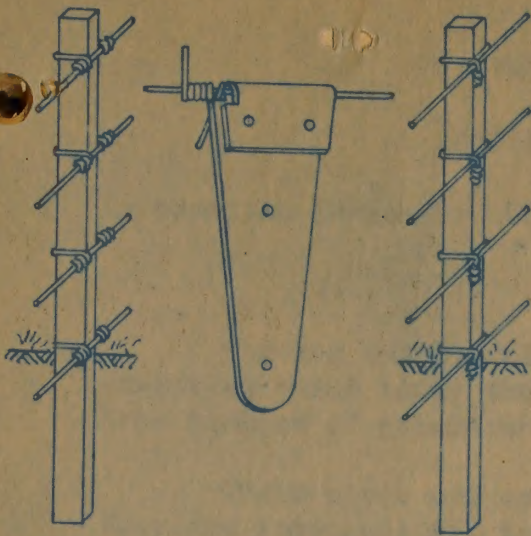
BRACKET FOR POST



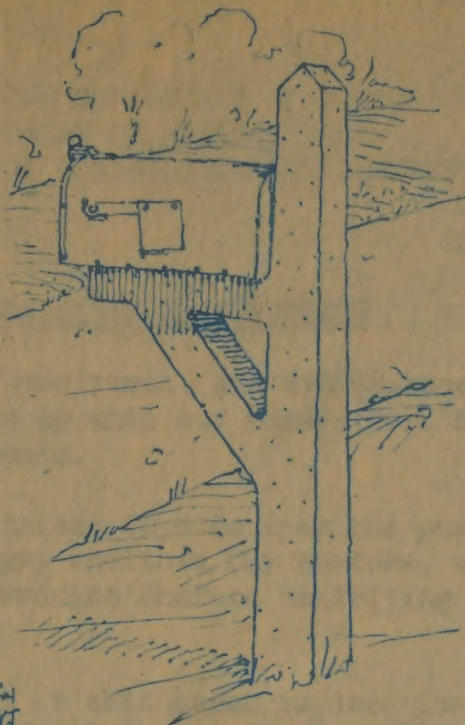
BRACKET FOR POST

CONCRETE POSTS  
The structure is shown in a perspective view, with the top surface divided into a grid of squares. The structure is supported by a series of vertical posts. The drawing is very faint and appears to be a technical sketch or a blueprint.

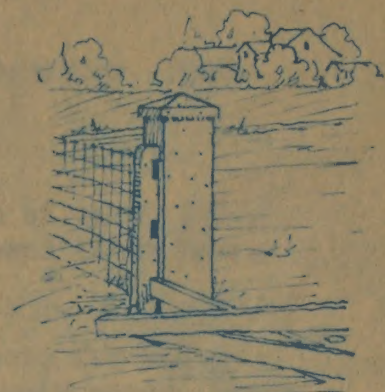




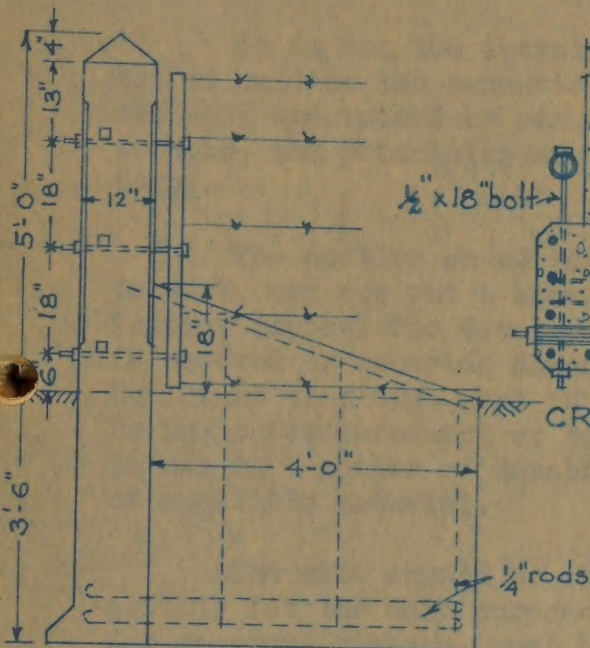
FASTENING WIRE TO POST



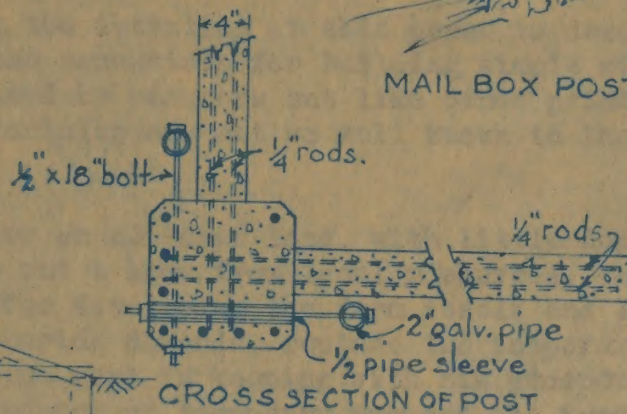
MAIL BOX POST



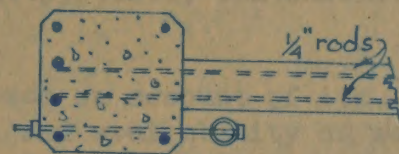
GATE POST FOR RAIL GATE



CORNER POST

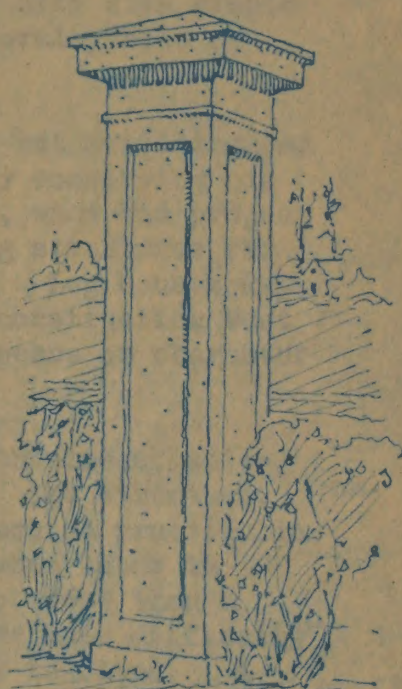


CROSS SECTION OF POST

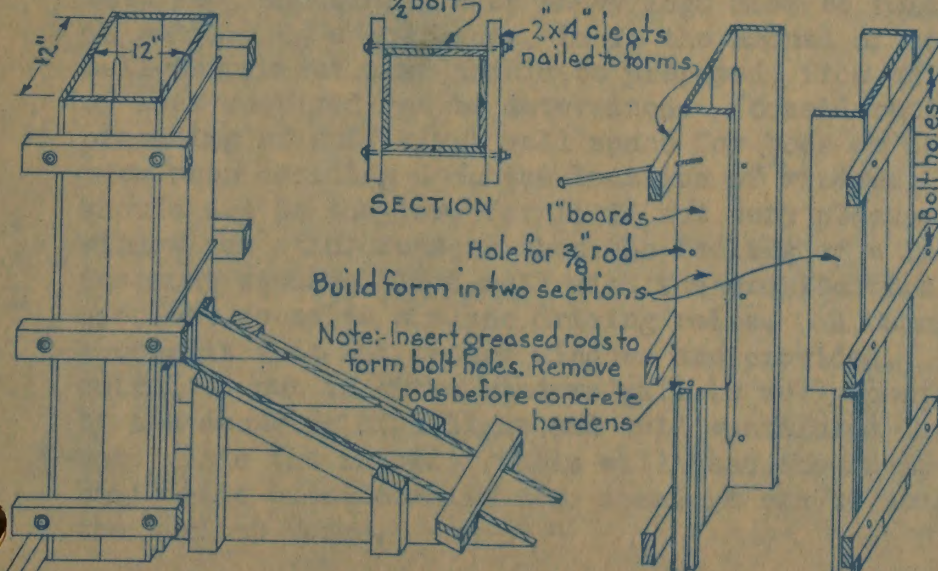


AS AN END POST

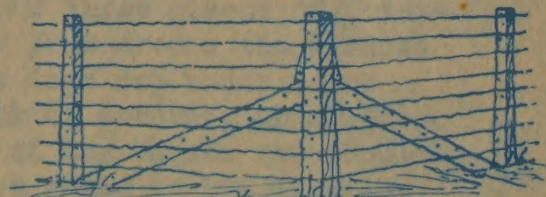
FIG. 2



ORNAMENTAL POST



FORM FOR CORNER POST AND BRACE



BRACED CORNER POST

|                                      |         |                      |  |
|--------------------------------------|---------|----------------------|--|
| U.S. DEPARTMENT OF AGRICULTURE       |         |                      |  |
| BUREAU OF PUBLIC ROADS               |         |                      |  |
| DIVISION OF AGRICULTURAL ENGINEERING |         |                      |  |
| CONCRETE POSTS                       |         |                      |  |
| Scale                                | CHECKED | SHEET 2 OF 2 SHEETS  |  |
| Drawn by                             |         | SUBJECT IN SERIAL N° |  |
| Traced by N.B.                       |         | 698A 2117            |  |
| APPROVED                             |         |                      |  |



THE UNITED STATES OF AMERICA  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT

TO THE SECRETARY OF THE INTERIOR  
FROM THE DIRECTOR OF THE BUREAU OF LAND MANAGEMENT  
SUBJECT: [Illegible]

1. [Illegible]  
2. [Illegible]  
3. [Illegible]  
4. [Illegible]  
5. [Illegible]  
6. [Illegible]  
7. [Illegible]  
8. [Illegible]  
9. [Illegible]  
10. [Illegible]



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 59.

September, 1925.

LOG CABIN CONSTRUCTION

The log cabin, full of sentiment, and ever a haven of rest, has a practical value today the same as when our forefathers hewed their homes from timbers of primitive forests.

Their style and completeness depends upon the purpose for which they are intended; as, temporary shelters for hunters, summer camps, homes for pioneers, or wonderfully wrought chalets exhibiting all the samples of an architect's fancy.

It is not the intention of this paper to describe this latter type but to outline the essentials for building simple structures of logs - an art well understood by pioneers but like other primitive arts with simple technic, its principles are not so well known to the general public of today.

The settler on cut-over land, with little capital but a willingness to work, can hew out a home from local resources, thereby conserving his initial capital for developing the farm itself and later, when his project is assured or occasion demands, replace the temporary log structures for buildings of a type more in keeping with his prosperity. Log houses may be built for permanent or temporary use and the type of construction best to use is a matter of durability, taste, convenience, expense or character of available material.

The site should be chosen on account of its, healthfulness, suitability for the main purpose, and availability of water. The structure, for economic reasons, must be designed to be built, as much as practicable, from materials at hand and it should be remembered that when labor is scarce a one or one-and-one-half story house is easier to erect than a tall one, especially when heavy logs must be raised. The main difficulty in putting up a log house, is in the amount of heavy work involved. A well-thought-out plan should be prepared, from which the number and size of logs required can be determined. Consideration should be given to the providing of sufficient wall space for beds or other large pieces of furniture when deciding upon the location of windows. In bedrooms the windows should not be too low, for it is not very pleasant to sleep under a low window for other reasons than the feeling of a lack of security or privacy. Casement windows blend well with the architecture of log houses and should open out so as to exclude driving rains. A common fault in building log houses is that not enough windows are provided. The additional time required to put in extra windows will be well spent in the advantages gained by the securing of a light and well ventilated dwelling. Chimneys when built into the interior walls will heat the rooms more easily than when built into outside walls also openings can be provided for stove pipes from the various rooms.



UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF ENTOMOLOGICAL RESEARCH  
DIVISION OF AGRICULTURAL ENGINEERING

September, 1935

Information Series No. 38

LOG CASKS

The log cask, full of sediment, has ever a heavy load. In practical use today the same is used for transporting heavy loads. The log cask is a primitive device. It is made of logs, and is used for transporting heavy loads. It is made of logs, and is used for transporting heavy loads. It is made of logs, and is used for transporting heavy loads.

It is not the intention of this series to discuss the log cask. It is not the intention of this series to discuss the log cask. It is not the intention of this series to discuss the log cask. It is not the intention of this series to discuss the log cask.

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The logs should be of a durable species of tree such as cedar, spruce, pine, hemlock, tamarack or balsam; the best hard woods will serve but are heavy to handle. Rough bark improves the appearance but is more subject to insects and borers and if it is to be left on, the trees should be cut in winter when the sap is down. To prevent bruising the bark the logs must be handled with care and it is advisable to haul them on a log boat and not to use chains or cant hooks. Bark can be easily removed when the sap is rising in the spring, by girdling the trees about every four feet of height and making a vertical cut so that an ax blade or other flat tool can be slipped between the bark and the wood. The bark will readily peel off in slabs 4 feet long and these should be laid on a flat surface and weighted down with stones for a few days to prevent them curling up. Sometimes the bark is used for temporary roofing slabs, interior veneer, paneling, or other decoration details. The logs should have little or no taper and may vary from 6 to 10 inches in diameter at the small end and should be 1 to 2 feet longer than the length or width of the building depending upon the type of lock-joint used at the corners. Where the log is not long enough to extend the length of a wall a splice joint can be made by halving the adjacent ends and tree-nailing but such joints detract somewhat from appearance.

The first consideration in building a log house is a suitable foundation. The choice of a type is determined by the necessity for permanence and may be made in one of the following ways:

The simplest footing for temporary structures consists of large flat stones laid on firm ground and should consist of at least two stones, because a rock in contact with the earth will sweat and the moisture in time will rot any wood in contact with it. This is easily avoided by using two rocks, one on top of the other since the upper one will not sweat.

Another type of stone footing sometimes used is made by filling a hole three feet deep about two feet in diameter, with small broken stone up to the ground level; care being taken that the stones are well settled together. Larger stones should be placed on these and chinked up so that they are well bedded in place.

Posts 10 to 12 inches are frequently used but should be of cedar, pine or other durable wood, unless creosoted. The hardwoods are not very durable for this purpose. The posts should be about 5 feet long, the bark being removed. They should be set about 3 feet into the ground with one end resting on flat stones.

Cement-laid masonry or concrete piers are very durable.

Piers should be set at the corners of the building and about 6 to 10 feet apart under the length of the walls or girders.

If the log house is to be lived in the year around, a full masonry wall will add much to comfort in winter. Holes properly screened should be provided in such a foundation to ventilate the underside of the floors.



The logs should be of a durable species of tree such as cedar, spruce, pine, hemlock, tamarack or balsam; the best hard woods will serve but are heavy to handle. Round bark improves the appearance but is more subject to insects and decay and it is to be left on the trees should be cut in winter when the sap is down. To prevent rotting the logs must be handled with care and it is advisable to nail them on a log post and not to use chains or cant hooks. Bark can be easily removed when the sap is rising in the spring, by stirring the trees about every four feet of height and making a vertical cut so that an air blade or other flat tool can be slipped between the bark and the wood. The bark will readily peel off in strips 4 feet long and these should be laid on a flat surface and weighted down with stones for a few days to prevent them curling up. Sometimes the bark is used for temporary footing alabs, interior veneer, girdling, or other decorations. The logs should have little or no taper and may vary from 8 to 10 inches in diameter at the small end and should be 1 to 2 feet longer than the length or width of the building depending upon the type of log-joint used at the corners. Where the log is not long enough to extend the length of a wall a splice joint can be made by halving the adjacent ends and cross-battling, but such joints detract somewhat from appearance.

The first consideration in building a log house is a suitable foundation. The choice of a type is determined by the necessity for permanence and may be made in one of the following ways:

The simplest footing for temporary structures consists of laying flat stones laid on firm ground and should consist of at least two stones, because a rock in contact with the earth will rot and the moisture in time will rot any wood in contact with it. This is easily avoided by using two rocks, one on top of the other since the upper one will not sweat.

Another type of stone footing sometimes used is made by filling a hole three feet deep about two feet in diameter, with small broken stones up to the ground level; care being taken that the stones are well settled together. Larger stones should be placed on these and chinked up so that they are well bedded in place.

Posts 10 to 12 inches are frequently used but should be of cedar, pine or other durable wood, unless exposed. The hardwoods are not very durable for this purpose. The posts should be about 5 feet long, the bark being removed. They should be set about 3 feet into the ground with one end resting on flat stones.

Cement-laid masonry or concrete piers are very durable.

Posts should be set at the corners of the building and about 6 to 10 feet apart along the length of the walls or girders.

If the log house is to be lived in the year around, a full masonry wall will add much to comfort in winter. Holes properly screened should be provided in such a foundation to ventilate the underside of the floor.



The strongest and best logs should be used for sills and first tiers. The bottom or sill log should have its upper surface hewn flat so that the narrowest part is 2 or 3 inches wide. The rest of the logs should be hewn flat top and bottom so that they will lie close together in adjacent tiers. In laying up a wall the butts and tops should alternate so that the wall lays up level and one corner will not raise higher than another; in fact it is advisable to level up the wall at several stages of operation before the top log or plate is reached. Where the ends are not locked and at every 9 feet in the length of the wall, the top log should be tree-nailed to the lower tiers by boring a 1-1/2 inch hole through the top log and one-half of the thickness of the log below and driving a hardwood pin into it. Several types of cuts used for locking the ends are shown which are made by hewing with an ax. The log is placed upon the wall in position and fitted to the log below. If the round notch is used the curve of the lower log is scribed on the top one to serve as a guide in cutting the notch.

No particular calculations are made for openings unless to place a poor part of the log where it will eventually be cut out. When the top of the windows and doors is reached, the top log of these spaces should be cut out and then the following tier laid; thus at a convenient time the opening may be made by sawing the logs below the one already cut out. This can be done most satisfactorily by means of a two-man saw guided by a 2 inch by 6 inch vertical plank nailed loosely to the face of the wall. The frames should be ready to put in place or 2 inch by 8 inch uprights provided for false jambs. These should be spiked to the face of the cut to hold the loose ends of the logs in place. Sometimes openings are formed by shorter logs, placed on either side of the openings, instead of by the method just described. This makes it necessary to use more care, and often more work, to get the top level so that the log, forming the lintel at the top of the opening which must extend across the entire side, can be fitted in place. It is advisable to bevel the ends of the logs at openings as shown.

When smooth inside walls are wanted, the inside faces of the logs should be hewn to a perpendicular plane with a broadaxe as the work progresses. In hunting cabins the inside of the logs are frequently left rounded to secure a rustic effect but in permanent dwellings they are generally hewn smooth, sheathed with tongued and grooved lumber, and sometimes plastered.

The floor for very temporary shacks may be of clay and sand rammed hard or puddle-logs (logs laid on the ground with the top surface hewn flat). The more permanent dwellings should have floor joists of logs or dimensioned lumber. Joist logs should be about 6 inches in diameter for 12 foot spans or less, 8 inches for 16 foot spans, and 9 or 10 inches for 20 foot spans, and should have one side flattened from end to end to make an even surface for the flooring to rest upon. This face, for 20 foot spans, should be crowned 2 inches in the center and proportionately for shorter spans; for, when put in place they will sag of their own weight. Seasoned logs are best for floor joists as they will not rot as



The strongest and best logs should be used for sills and first  
 floor. The bottom or sill log should have its upper surface down flat  
 so that the narrowest part is 2 or 3 inches wide. The rest of the logs  
 should be down flat top and bottom so that they will lie close together  
 in adjacent tiers. In laying up a wall the first and top should often  
 make so that the wall lays up level and one corner will not rise higher  
 than another; in fact it is impossible to level up the wall at several  
 stages of operation before the top log or plate is reached. Where the  
 ends are not locked and at every 2 feet in the length of the wall, the  
 top log should be cross-banded to the lower tiers by boring a 1-1/2 inch  
 hole through the top log and one-half of the thickness of the log below  
 and driving a hardwood pin into it. Several types of cuts made for lock-  
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 door part of the log where it will be convenient to enter and exit. When the top  
 of the windows and doors is reached, the top log thickness should be  
 cut out and then the following log laid in position. This  
 opening may be made by using the log below the opening already cut out. This  
 can be done most satisfactorily by means of a circular saw guided by a 2  
 inch by 8 inch vertical plank nailed loosely to the face of the wall. The  
 frames should be ready to put in place or 2 inch by 8 inch uprights pro-  
 vided for false jambs. These should be placed at the face of the wall  
 to hold the loose ends of the logs in place. Sometimes openings are  
 formed by shorter logs placed on either side of the opening, instead  
 of by the method just described. This method is necessary in the case  
 of small openings. To get the top leveling that the log, forming  
 the lintel of the top of the opening which must extend across the entire  
 side, can be fitted in place. It is advisable to level the ends of the  
 logs at openings as shown.

When inside walls are wanted, the inside faces of the logs  
 should be down to a perpendicular plane with a thickness as the work pro-  
 ceeds. In building outside the inside of the logs are proportionally left  
 rounded to secure a snug fit. In permanent dwellings they are  
 generally down smooth, rounded with rounded and grooved jambs, and  
 sometimes plastered.

The floor for very temporary houses may be of clay and used for  
 hard or middle-log (log laid on the ground with the top surface down  
 flat). The more permanent dwellings should have floor joists of logs  
 or dimensioned lumber. Floor joists should be about 6 inches in diameter  
 for 12 foot spans or less, 8 inches for 12 foot spans, and 10 inches  
 for 20 foot spans, and should have one inch dimensioned top and bottom  
 made on even surfaces for the flooring to rest upon. This case, for 20  
 foot spans, should be covered 3 inches in the center and proportionately  
 for shorter spans. For spans not in place they will sag of their own  
 weight. Seasoned logs are best for floor joists as they will not sag



easily as green logs nor are they as likely to warp or check. The joists should be spaced from 2 to 3 feet apart, depending upon their size, and should be framed to the sill logs as the building progresses. Where dimensioned joists are used the conventional method of framing should be followed. Framing should be kept 2 inches away from chimneys to prevent possible charring of the wood.

The roof should be  $1/4$  to  $1/2$  pitch to shed water quickly. One-fourth pitch is a slope of  $22\text{-}1/2$  degrees and the peak is  $1/4$  the length of the span above the plate. One-half pitch is a slope of 45 degrees and the peak is  $1/2$  the length of the span above the plate. Poles 4 to 6 inches in diameter can be used for the roof framing, depending upon the span, but should not be cut any more than necessary. Shakes or slabs, if not too heavy or thick, can be used for roof sheathing by placing the sawed side up and fitting them to the rafters so as to secure a fairly smooth surface. The edges should be trimmed so that the shakes will lie close when tar paper or composition roofing is to be used but can be spaced apart for wood shingles. Frequently 1" x 4" roofing slats, spaced 6 inches on centers, are used with wood shingles. Sometimes 3 to 4 inch poles are placed horizontally 2 feet apart for the roof framing and membered with the gable walls - shakes, sheathing or bark being secured to them. If bark is used it should be in four foot lengths and lapped 6 inches but as it makes only a very temporary roof it should not be considered seriously as a roofing material. Shingles make a fairly enduring roof that can be counted upon to last from 10 to 15 years, and longer if of good hand-wrought cedar or white pine well laid, and besides blend with the architecture; spruce and hemlock will serve for shingles. Shingles should be laid  $4\text{-}1/2$  inches to the weather on  $1/4$  pitch roofs and  $5\text{-}1/2$  inches on  $1/2$  and over pitches. One thousand shingles, laid 5 inches exposed, will cover 130 square feet of roof. The first course at eaves should be doubled. To avoid leakage the ridges, valleys and hips should, in the more permanent type of structure, be covered with a strip of tin or heavy tarred felt 12 inches wide before the shingles are laid; also, chimneys should be flashed. The ridge should have saddle-boards made by nailing two 6" boards into a V-shape or a pole 4 inches in diameter with a V-shape groove. This latter is more picturesque. Besides shingles, the various commercial coverings such as, tarred composition roofing in shingles or sheets, and corrugated galvanized sheet metal are used to advantage but at a sacrifice to the spirit of a "cabin".

Sometimes the logs are not hewn flat and the ends are notched very little for structures not requiring absolute weather-tightness, such as, corn cribs, wagon, wood or hay sheds. This method produces a rather crude wall and is not very practical except when the openings do not have to be filled. It is of course, quicker and easier than fitting the logs close. For ordinary buildings it is more satisfactory to notch the ends of the logs a little deeper, and even if they are not hewn flat, enough of the bends, knots, etc, should be trimmed so that the logs will fit fairly tight on one another.



usually as given, but they are likely to vary or change. The joints should be spaced from 2 to 3 feet apart, depending upon their size, and should be framed to the sill logs as the building progresses. These dismantled joints are used the conventional method of framing should be followed. Framing should be kept 2 inches away from chimneys to prevent possible charring of the wood.

The roof should be 1/4 to 1/2 pitch to shed water quickly. One-fourth pitch is a slope of 22-1/2 degrees and the peak is 1/4 the length of the span above the plate. One-half pitch is a slope of 45 degrees and the peak is 1/2 the length of the span above the plate. Poles 4 to 6 inches in diameter can be used for the roof framing, depending upon the span, but should not be cut any more than necessary. Shakes or slabs, if not too heavy or thick, can be used for roof sheathing by placing the same side up and fitting them to the rafters so as to secure a fairly smooth surface. The edges should be trimmed so that the shingles will lie close when tar paper or composition roofing is to be used but can be spaced apart for wood shingles. Frequently 12 x 40 roofing slabs, spaced 6 inches on centers, are used with wood shingles. Sometimes 2 to 4 inch poles are placed horizontally 2 feet apart for the roof framing and run parallel with the gable walls - shakes, sheathing or bark being secured to them. If bark is used it should be in four foot lengths and lagged 6 inches but as it makes only a very temporary roof it should not be considered seriously as a roofing material. Shingles make a fairly enduring roof that can be counted upon to last from 10 to 15 years, and longer if of good hard-wood cut on white pine well laid, and besides shingles with the architecture, bark and bark-like will serve for shingles. Shingles should be laid on 1/4 inch poles or 1/2 inch poles on 1/4 inch poles and 3/4 inch poles on 1/2 inch poles. The first course 5 inches exposed, at corners, at gables, at ridges, valleys and hips at eaves should be banded with 1/2 inch poles. The shingles are laid; should, in the next paragraph, be covered with a strip of tin or heavy canvas 1/2 inch wide along the shingles are laid; also, chimneys should be banded. The shingles have double-banded with by nailing two 6 inch poles a 7 inch gap in the shingles. Shingles with a 7 inch gap. This latter is the conventional. Shingles, the various material covering and as framed composition roofing is shingles shingles, and suggested covered about metal are used to advantage but as a sacrifice to the style of a building.

Sometimes the logs are not banded like the ends are banded very little for appearance and regarding the roof of the building, such as, some canvas, wicker, wood or bark shingles. This method produces a rather crude wall and is not very practical except when the openings do not have to be filled. It is of course, durable and better than filling the logs. For ordinary buildings it is more satisfactory to notch the ends of the logs a little, and even if the logs are not banded like, smooth of the peaks, valleys, etc., should be trimmed so that the logs will fit fairly tight on one another.



To insure a perfectly stormproof structure the spaces or cracks between the logs must be sealed but this should be deferred as long as practicable so that the logs will have an opportunity to dry. If a little care is taken in fitting and matching the logs, as the house is being put up, the chinking will be comparatively easy. At best much of this work has to be repeated the second season, especially if the joints are wide, so that it might be well to defer the interior trim until the second year. Where the logs have been laid up with wide spaces between them, as is the practice in some localities, these spaces are filled with slabs of stone laid to an angle of about  $45^{\circ}$  to  $60^{\circ}$  and bedded in clay, lime mortar or cement mortar thus causing the wall to appear as alternate layers of timber and masonry. Mix the clay as you would mortar, to the softness of putty, and push balls of it between the chinks. The clay chinking, when well done, will last from 10 to 12 years.

When the logs have been laid up close, the narrow cracks can be caulked with cotton waste, oakum or sphagnum moss (the kind found in swamps and also used by florists for wrapping plant roots). These materials are forced into the joints from both sides of the log with a wooden wedge or caulking iron struck with a mallet. If the joint is wide it can be stopped up with pieces of wood, made by quartering short lengths of logs, cut to fit the crack, nailed in place and bedded in clay or cement mortar. If the nails are not driven their full length, the protruding heads serve as a key to hold the mortar.

Cement mortar can be substituted for any of the above materials; in fact, it would improve the appearance and durability of the joints if used for pointing-up on the outside. The attached sketches illustrate the essential details and one type of house of log construction. Many other designs can be skillfully woven in the structure so as to introduce a "personal touch", produce a suggestion of delicate detailing or rugged simplicity. Frequently wide verandas or porches with a roof supported by log posts surround the house where summer living is the main use of the cabin.

#### Pole and Slab Construction.

Buildings with walls made by placing logs on end instead of laying them horizontally, are commonly referred to as pole houses. Such structures are easier to build because one man can handle the logs since short lengths of small-diameter poles are generally used; also, the labor of notching at the corners is not required.

This method of handling logs is admirably suited to small buildings and lends itself to considerable variation of architectural expression however such structures are not as substantial as are log houses. The poles should not be smaller than 4 to 5 inches in diameter and if of uniform diameter or taper produce a rustic effect. If a weather-tight wall is desired the logs should be hewn on the sides and matched to fit close together. The cracks are chinked in the same manner as are log houses.







A secure foundation should be provided upon which should be bolted a sill 4 to 6 inches square of either a hewn log or several sawed timbers. The sill must be smooth and level on the top surface for the sawed ends of the poles to rest upon. A similar timber will be required as a plate or cap to hold the top of the poles. The plates and sills should be halved and lapped at corners. The upright poles are sawed to a length equal to the proposed distance between the top of the sill and under side of the plate. The corner poles are set first and the plates set on top of them. The other poles are matched and fitted one at a time and spiked to the plates and sills.

No difficulty will be experienced in forming openings, however, precaution should be taken to make the sills and lintels level, jambs plumb and the opening a uniform width. The roof framing can be executed as for an ordinary log house.

"

Frequently the gable ends of log houses, above the roof plates, are formed with poles to secure a contrast with the wall proper. Slabs or shakes are employed for this purpose at times. Fences, furniture, wagon and feed racks, stalls and many other pieces of equipment can be cheaply and artistically made of poles  $1\frac{1}{2}$  to 2 inches in diameter.

Walls can be built of slabs or shakes instead of poles and generally consist of two layers; the two sawed faces being placed adjacent so that both the inside and outside wall surfaces show the rounded faces. The two layers are staggered so as to close the joints making them weathertight and should be well spiked together, this method of building walls is best adapted to interior partitions or very temporary and small outbuildings.

BEFORE FELLING A TREE BE SURE THAT IT WILL BE USED BECAUSE IN FIFTEEN MINUTES THE WORK OF 20 YEARS WILL BE UNDONE.

Certain timber has a sale value as logs, cordwood, bolts, ties, and for manufacturing purposes, therefore, if the construction of a log house is contemplated upon the basis of providing a cheap shelter, the probability of marketing the timber should be investigated; because frequently sufficient money may be realized, by selling the timber, to permit the erection of a house of a more conventional type. In this connection the information in the following Farmers' Bulletins will be helpful.

- # 1100, "Cooperative Marketing of Woodland Products."
- # 1117, "Forestry and Farm Income."
- # 1210, "Measuring and Marketing Farm Timber."

The chimney should be well built especially if the log house is to be a home. A mud and log stack while picturesque is an expensive luxury and should not be used unless, as a veneer, to surround a masonry stack. Chimney and fireplace construction is described in Farmers'







Bulletin 1230, "Chimneys and Fireplaces." Farmers' Bulletin 1279 describes the method of making concrete and mortar. While Farmers' Bulletin 1227, "Sewage and Sewerage of Farm Homes," contains valuable suggestions that are practical for permanent houses or camps. If whitewash is needed the formulas given in Farmers' Bulletin 1452, "Painting on the Farm," will be of interest. These bulletins can be obtained from the Office of Publications, U. S. Department of Agriculture, Washington, D. C., as long as their supply lasts.

Other suggestions can be obtained from the following books:

Boy Scouts of America Handbook, 200-5th Ave., New York, N. Y.  
Shacks, Shelters and Shanties by Daniel C. Beard.  
Log Cabins and Cottages by William S. Wick, Forest and Stream Publishing Company, New York, N. Y.  
Wilderness Homes - Oliver Kemp, The Outing Publishing Co., New York, N. Y.

The Extension Division of the Michigan Agricultural College, East Lansing, Michigan, has published Extension Bulletin 24, "Utilizing Poles and Timber in Farm Building," which illustrates the method of building pole house and farm equipment.

The following periodicals publish illustrations from time to time of log house construction and can be consulted at most public libraries. House and Garden; Country Life; The Delineator; Keiths Magazine; and Country Gentleman.

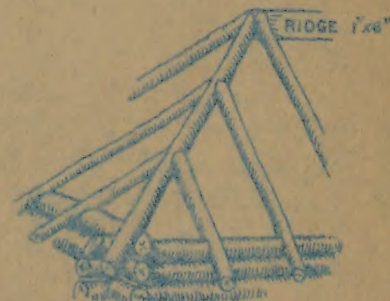
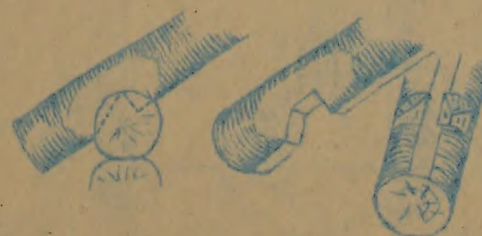
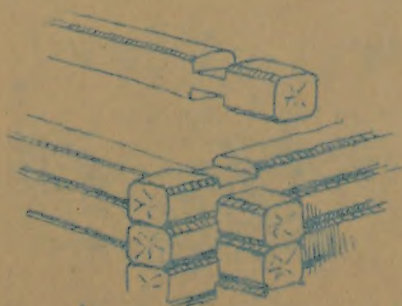
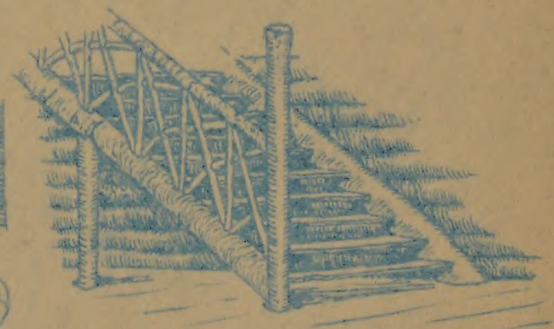
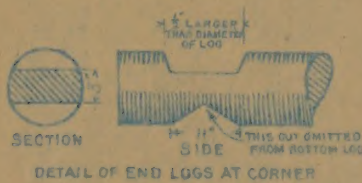
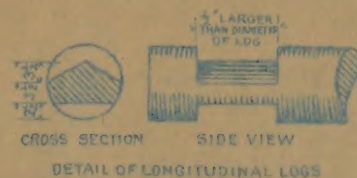
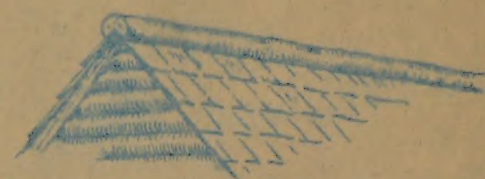
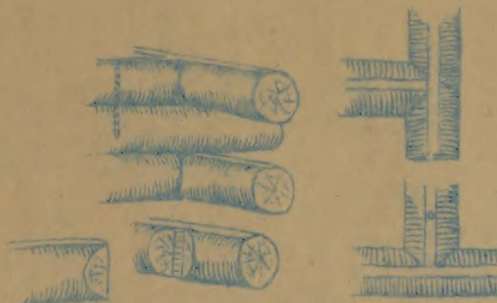
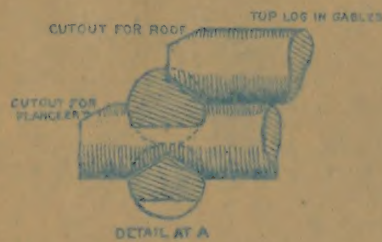
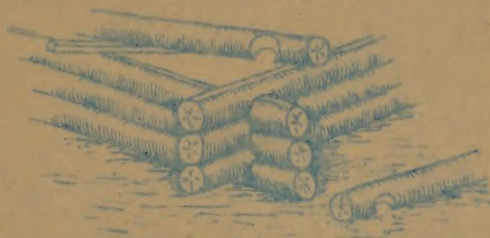
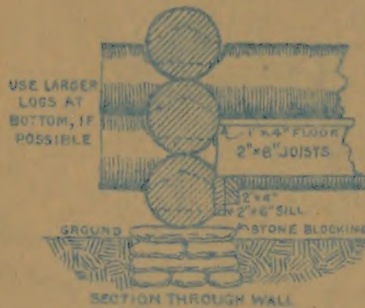
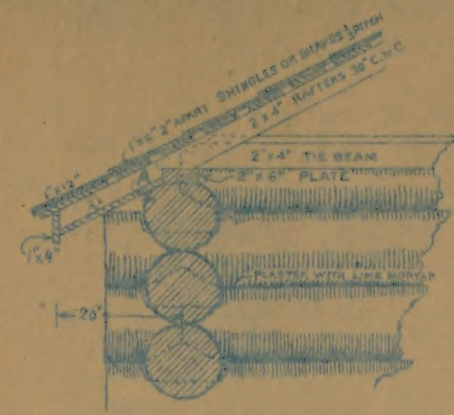
Drawings, Serial Nos. 2135 and 2136 accompany this Information Series.







## DIVISION OF AGRICULTURAL ENGINEERING

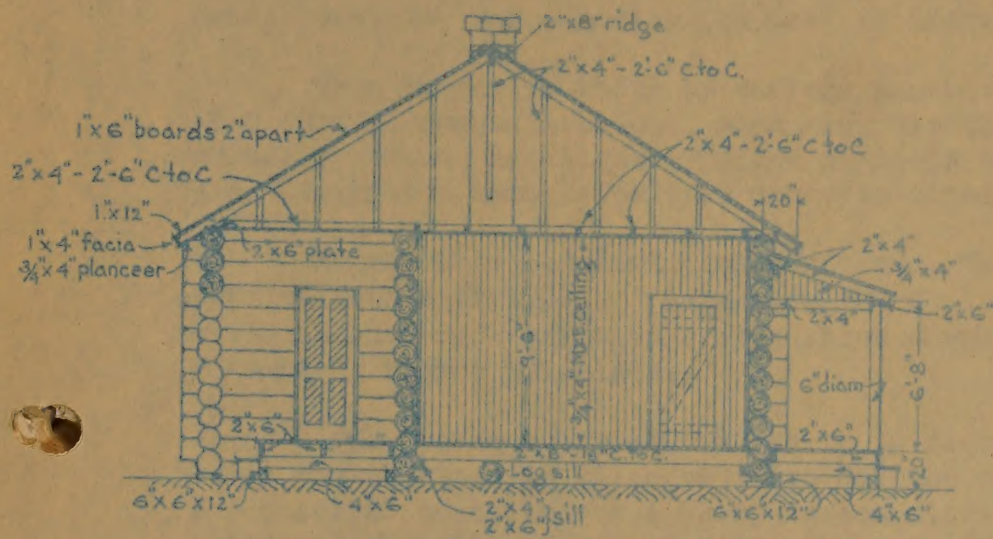


## LOG HOUSE DETAILS



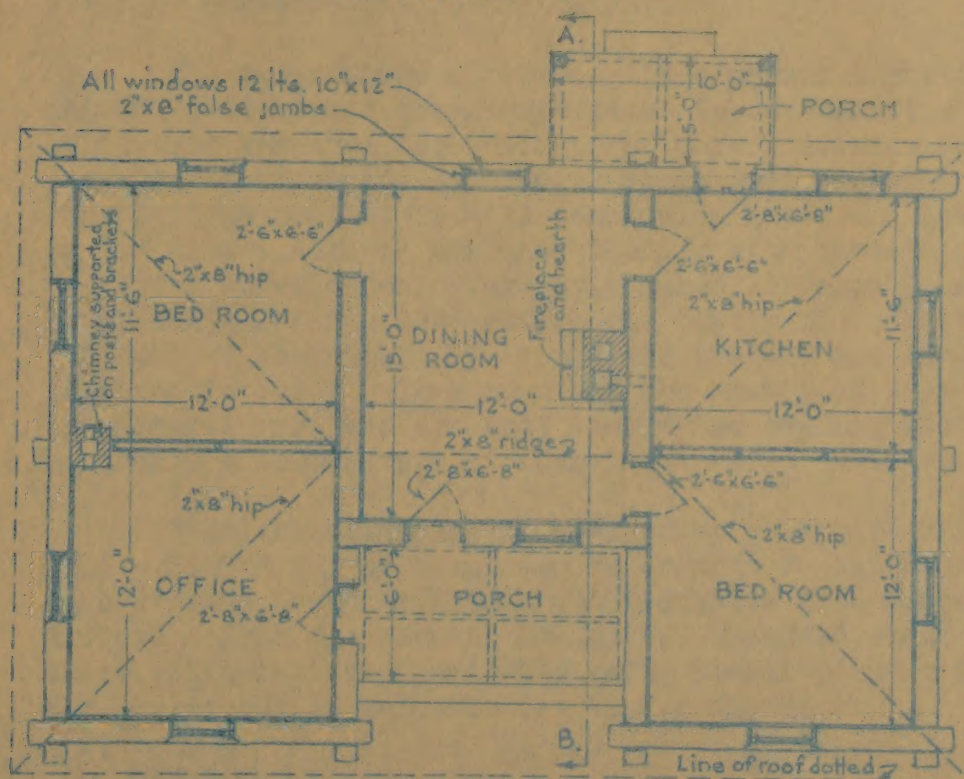






SECTION A-B

DETAIL



FLOOR PLAN  
0 1' 2' 3' 4' 5' 6'  
scale in feet

# LOG HOUSE

DIVISION OF AGRICULTURAL ENGINEERING  
BUREAU OF PUBLIC ROADS  
U.S. DEPT. OF AGRICULTURE







UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 60.

December, 1925.

MAGNESIA CEMENT FLOORS AND STUCCO

Although the cement produced by the reaction of caustic magnesia with a solution of magnesium chloride has been known since 1853 when Stanislaus T. Sorel discovered oxychloride cement, its commercial utilization has been hampered by the secrecy maintained in the past by those who manufactured it.

Within recent years the public has begun to realize its value and limitations and also the general similarity between the variously named products; consequently its use is increasing.

This cement is known by various names, viz: Sorel cement, magnesite cement, magnesia cement, magnesium oxychloride cement, plastic magnesia cement, and light calcined magnesia cement. A more appropriate and descriptive name is caustic magnesia cement.

Magnesia is obtained from magnesite, which is the natural magnesium carbonate ( $Mg CO_3$ ). Magnesite ( $Mg CO_3$ ) usually occurs as a dense white massive rock and when broken shows a smooth white opaque surface resembling broken porcelain.

After being quarried, magnesite is broken up into medium sized lumps and calcined in kilns to drive off the carbon dioxide; when pure the material contains about 52.4% carbon dioxide and 47.6% magnesium oxide and when burned commercially about 2-1/3 tons of the rock produce 1 ton of magnesia (magnesium oxide).

The temperature of burning is of great importance. If the magnesite is heated to a temperature (about 950°F) which is considerably below that required for fusion, the carbon dioxide can be liberated leaving the magnesium oxide with properties somewhat like those of caustic lime in that it will react with water and the carbon dioxide of the air. Also it combines readily with certain other reagents as magnesium chloride which property makes it valuable as a cement. The lower the calcining temperature the faster the cement will set, also the smaller the amount of iron oxide content the lower the temperature required to burn. On account of the amount of iron oxide present in the natural rock and the fact that a too quickly setting cement is not desirable a temperature of from 1300 - 1700° F is usually employed.

When the calcining is carried on at a much higher temperature 2700 - 3100°F the material can be brought to incipient fusion resulting in a product known as dead burnt magnesite with properties entirely different from the caustic magnesia. The dead burnt magnesite is very dense, fire-resistant and chemically inactive and consequently is unfit for cement but is valuable for lining furnaces.







Most of the magnesite mined in the United States comes from California and Washington though there are deposits of the rock in other States.

The magnesium chloride is mainly a by-product in the manufacture of other substances. At salt works it is made from the bittern water or refuse left in the evaporating pans after the salt has crystallized out.

In preparing the magnesia cement the magnesia or magnesium oxide is mixed with various inert materials, as are Portland cement and aggregates, and then gaged or wetted with a solution of magnesium chloride. A solution of almost any strength will produce setting and a slight set can be obtained sometimes with water alone but a solution having a density of 20°Baume (Sp Gr. 1.16) is generally used.

Manufacturers mix the ingredients according to their own formula depending upon the properties they desire to develop to fit the cement for special purposes. Usually the ingredients are marketed in two parts, the magnesia and inert materials already mixed together and the liquid which must be diluted and incorporated with the solids just before use. There are no standard formulas nor are there standard specifications therefore manufacturers in selling their products under trade names have directions for using the cement for each operation and kind of work while many will not guarantee satisfactory results unless handled by workmen experienced in manipulating magnesia cement.

#### Flooring.

The properties of composition flooring depend upon the ingredients which are mixed with the cement. The floors may vary from a hard, dense type to one comparatively soft and resilient. Many different materials have been used in flooring mixtures to bring out certain of these qualities as sand, ground silica, sawdust and other fibrous vegetable matter, asbestos, leather scrap, ground cork, talc, clay, kieselguhr, and pigments. Many different formulas are used, even though the types of floor may be identical. Some are patented and others, in a way, are secret. The more common resilient type flooring mixtures is represented by the formula given below:

| Ingredients             | Bottom Coat<br>% by Weight | Top Coat<br>% by Weight. |
|-------------------------|----------------------------|--------------------------|
| Caustic Magnesia        | 35.                        | 45.0                     |
| Sand                    | 7.5                        | --                       |
| Ground Silica           | 25.0                       | 20.0                     |
| Sawdust                 | 25.0                       | --                       |
| Wood Flour              | --                         | 10.0                     |
| Asbestos Fibre          | --                         | 5.0                      |
| Clay, Talc or Sil-o-cel | 7.5                        | 10.0                     |
| Pigment                 | --                         | 10.0                     |



Most of the important work in the United States is done in California and Washington and the majority of the work in other States.

The important work in the United States is done in California and Washington and the majority of the work in other States.

In preparing the manuscript of this report the following facts were taken into consideration: (1) The fact that the work in the United States is done in California and Washington and the majority of the work in other States.

Manufacture and the investigation of the work in the United States is done in California and Washington and the majority of the work in other States.

The production of composite figures from the data of the work in the United States is done in California and Washington and the majority of the work in other States.

| Table 1 |       | Table 2 |       |
|---------|-------|---------|-------|
| Year    | Value | Year    | Value |
| 1910    | 10.0  | 1910    | 10.0  |
| 1911    | 10.0  | 1911    | 10.0  |
| 1912    | 10.0  | 1912    | 10.0  |
| 1913    | 10.0  | 1913    | 10.0  |
| 1914    | 10.0  | 1914    | 10.0  |
| 1915    | 10.0  | 1915    | 10.0  |
| 1916    | 10.0  | 1916    | 10.0  |
| 1917    | 10.0  | 1917    | 10.0  |
| 1918    | 10.0  | 1918    | 10.0  |
| 1919    | 10.0  | 1919    | 10.0  |
| 1920    | 10.0  | 1920    | 10.0  |



It should be understood that these formulas are not to be followed exactly for general use. The quality of the magnesite, the physical properties of the inert materials, and the type of floor desired will make modifications necessary in order to obtain the best results. A great deal of experience and some testing of the ingredients is a prerequisite to the proportioning of the floor mixtures.

The ground silica or other fine inert material serves to dilute the magnesia, which to a degree is essential in guarding against large changes in volume typical of the oxychloride cement if used alone. The fibrous materials, especially sawdust and wood flour, and probably sil-o-cel produce resiliency; clay and talc act as dilutents but are used chiefly to make troweling easier and to add to the smoothness of the surface. Asbestos fibers add also to the working qualities of the wet mixture.

The dry ingredients should be thoroughly mixed and when ready to use should be made plastic with a solution of magnesium chloride (22° B). The mixture may then be placed in the same manner as Portland cement floors are laid. The floor is given a final troweling after it has stiffened considerably but before it has become non-plastic. This operation produces a more compact and smooth surface making it more resistant to wear and more suitable for polishing and waxing. One without experience should not attempt to lay a composition flooring except under the supervision of an experienced operator.

Composition floors are laid in one or two coats each usually 1/4 or 3/8 inch thick. Often if two coats are used, as over wood, reinforcing in the form of wire netting or mesh is fastened to the floor. There is no uniform practice in the use of reinforcing or in the use of the bottom coat.

The foundation or base for composition floorings is an important factor which affects their durability. The base may be wood, concrete, iron or steel. Wood floors should be well seasoned, of planks not over 6 inches wide and not less than 7/8-inch thick and must be securely face-nailed at both edges and at each support to prevent cupping of the boards. Where possible it is best to lay the floor rough side up, while tongue and grooved boards are desirable. If reinforcement is used the metal should be 27 gauge securely fastened at intervals of 6 inches.

The surface of concrete slabs should be leveled and all holes or pockets eliminated. When conduits are buried in the concrete a cinder fill is not necessary. A cinder fill should not be placed until after the plastering is finished because the lime in any plaster which might fall on the cinders is very detrimental to the composition flooring and hard to remove from the cinders.







The desirable qualities of composition flooring are:

- Adaptability for covering old floors.
- Variety of colors which may be obtained by the use of various pigments.
- Resiliency.
- Sanitary advantages owing to the absence of a large amount of cracks or joints and low absorption.
- It is fire resistant but no fireproof.
- It can be laid and be ready for use in a comparatively short time.

#### Stucco.

The work to be done by an exterior stucco varies materially from that of a flooring material. The latter requires the properties of durability needed to resist abrasion, impact and structural stresses. An exterior stucco requires the properties of durability needed to resist the action of the elements and minor disarrangements of the structure coated.

Magnesia stucco has a number of attractive features. Owing to the low freezing point of the magnesium chloride solution which is used for wetting the dry mixture, it can be placed during cold weather with very little or any danger of freezing. There is not the tendency to craze or form map cracks upon setting as in Portland cement stucco. On account of the very low amount of cementing material used in the stucco mixture and consequently the great amount of inert material, this type of stucco seems to show very slight volume changes produced by humidity changes in the atmosphere and by the process of setting. This is one of the reasons for the small amount of cracking usually noted and the absence of crazing. The tensile and compressive strength of such lean mixtures is high compared with other types of stucco which are made of mixtures with higher percentages of cementing materials.

Magnesia cement possesses a marked ability to adhere to all materials. It is applied over the same bases that are suitable for Portland cement. If metal lath is used as a base it should be galvanized or otherwise protected since the stucco will corrode metal.

This kind of stucco usually consists of two coats, scratch and finish. If a dash is used it is imbedded in the finish coat by throwing against the soft mixture on the wall, with the hand or a paddle. White sand is generally used in the finish coat for the sake of appearance.

Below is an example of the materials comprising a finish coat of stucco:

|                  | Per cent by weight. |
|------------------|---------------------|
| Caustic Magnesia | 15                  |
| Asbestos Fibre   | 3                   |
| Ground Silica    | 15                  |
| Sand             | 67                  |







The under coat might contain less magnesia and some cork. As in floor compositions an ordinary colored sand could be used. The best results may be had by intelligently modifying the above proportions according to the properties of the plastic magnesia and inert materials.

The dry mixtures are gaged with a magnesium chloride solution (22°B) to a good workable consistency and applied to the wall with a trowel. The scratch coat should be used to even the surface and cover the high places to a depth of about 1/4 inch. The finish coat is applied to a depth of about 1/4 inch and may be placed at any time after the scratch coat has hardened sufficiently to support the finish coat without sagging.

If the surface to be covered is dry it is customary to wet this with the magnesium chloride solution or a thin mixture of caustic magnesia and magnesium chloride just previous to the application of the stucco coat to prevent excessive absorption of the solution with the mixture.

#### References to Magnesia Cements and Magnesite.

##### The American Architect (Volume CXIV)

- July 24, 1918, The properties of flooring materials.  
(comparison of magnesite and others)
- Sept. 11, 1918. Describes the manufacture of magnesia.
- " 25, 1918, Describes magnesia cement floors.
- Oct. 9, 1918, Describes magnesite cement stucco.

##### U. S. Geological Survey.

- Bulletin 66-BB (1917) Gives the amount of magnesite produced and imported from 1912-1916.
- Mineral Resources of the U. S. year 1914. Part II, Page 583; Sources of supply of magnesite.

##### Department of Commerce - Bureau of Standards.

- Circular 135, "Caustic Magnesia Cement."
- Technological Paper 239, Tests of Caustic Magnesia made from Magnesite from Several Sources.
- Technological Paper 70, "Durability of Stucco and Plaster Construction."

##### Journal of American Ceramic Society, Vol 4 #7, July, 1921. Plastic Magnesia Cements.

##### Journal of Society of Chemical Industry, May 31, 1901. The Indian magnesite industry.



The subject of this report is the study of the various factors which influence the rate of growth of the human body. The study is based on the results of a series of experiments conducted by the author and his colleagues. The results show that the rate of growth is influenced by a number of factors, including the amount of food, the amount of exercise, and the amount of rest.

The first factor which influences the rate of growth is the amount of food. The more food a person eats, the more he grows. This is because food provides the energy and the raw materials which are necessary for growth. The second factor is the amount of exercise. Exercise stimulates the growth of the body by increasing the circulation of the blood and by increasing the activity of the various organs. The third factor is the amount of rest. Rest is necessary for growth because it allows the body to recover from the wear and tear of daily life.

It is therefore evident that the rate of growth is influenced by a number of factors. These factors are the amount of food, the amount of exercise, and the amount of rest. The study of these factors is important because it allows us to understand the process of growth and to control it. This is important for the health and the well-being of the human body.

References to Reports on Growth and Development.

1. "The Human Body," by W. H. R. Rivers, 1917.

2. "The Human Body," by W. H. R. Rivers, 1917.

3. "The Human Body," by W. H. R. Rivers, 1917.

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18. "The Human Body," by W. H. R. Rivers, 1917.

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25. "The Human Body," by W. H. R. Rivers, 1917.



Engineering Station Bulletin #879, University of Wisconsin,  
Madison, Wisc. "The Physical Properties of Magnesia Cement  
and Magnesia Cement Compounds."

Journal of Chemical Technology, November 1912, "Magnesite - Its  
Preparation and Technical Uses."

The Daw Chemical Co., Midland, Mich. This corporation has dis-  
tributed a series of mimeographed reports dealing with Magne-  
sium oxychloride products and their testing - See Magnesium  
Chloride Service Bulletin # 6.

Manufacturers of Magnesia Cement Flooring and Stucco.

U. S. Materials Co., Weed Street and Sheffield Ave., Chicago, Ill.  
American Materials Co., 101 Park Avenue, New York, N. Y.  
The Marbeloid Co., Broadway and 34th Street, New York, N. Y.  
Sanitary Composition Floor Co., Syracuse, N. Y.  
Special Service Flooring Corporation, Grand Terminal, N. Y.  
National Hygienic Floor Co., 3031 Olive St., St. Louis, Mo.  
Franklin R. Muller & Co., 900 Madison St., Waukegan, Ill.  
General Kompolite Co., 325-327 Borden Avenue, New York, N. Y.  
Chency & Co. Inc., 110 W. 40th Street, New York, N. Y.  
National Kellastone Co., 155 E. Superior St., Chicago, Ill.



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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PUBLIC ROADS  
DIVISION OF AGRICULTURAL ENGINEERING

Information Series No. 61.

January, 1926.

RAT PROOFING BUILDINGS.

The depredations of rats and mice are too frequently taken as a matter of course and little effort is made to prevent them. Estimates of the amount of damage done by them have been placed at from \$1.50 to \$5.00 per rat per year - this is very high but yet their destruction is great for it is a common experience for poultry raisers to lose 25 to 50% of the young chickens; not to mention their destruction of food and property.

Little relief can be expected from rats by eliminating them from one building only, the premises should be cleared of them, while greater security is assured by chasing them from the community instead of from one building to another.

The presence of a large number of rats denotes that conditions exist which are favorable to their growth. The first measure to be taken towards conquering this pest is to exclude them from food and then do away with breeding places. Scarcity of food makes measures for destroying more effective because a poorly fed rat will be more likely to disregard its well developed intelligence and caution and walk into a trap or consume poisoned food. Trapping and poisoning are only expedients and some authorities claim that with the temporary reduction in rat population by these methods the relatively increased food supply and harborage stimulate breeding and longevity of life. An ill fed rat will bring forth litters of 4 to 8 while a well fed rat provided with good shelter will bear 10 to 18 young 4 to 5 times each year. Therefore keep a rat hungry while its breeding places are being destroyed simultaneously in the special structure desired and vicinity.

There is no one system of ratproofing that is generally applicable to all structures. The main object is to remove all possible entrances and nesting places.

A favorite nesting and feeding place of rats is under old wooden floors, between ceilings and under rubbish. Concrete foundations extending two feet into the ground and two feet high are very effective barriers especially when a concrete floor is provided but are not sufficient if under a frame structure. The stud space between the sheathing and plaster should be dammed by a filling of concrete or other masonry so as to extend from the top of the concrete foundation to 6 inches above the floor level. All other openings such as ventilators, open pipe holes and basement windows should be screened. The addition of inner doors to vestibules of public buildings, such as stores, is advisable. The lower part of the outside doors should be protected with light metal plates to prevent the rats gnawing through.







Floors supported on timbers resting on the ground should be replaced with concrete or if the structure is small it may be raised bodily on piers 2 to 3 feet high so that the ground below will be clear. The tops of the piers if of timber may be protected with bands of sheet metal which will prevent a foothold.

It is hardly practicable to rat proof large structures such as barns, owing to the necessity of leaving the doors open for long periods of time yet a concrete floor is very desirable. Food bins and cribs within the barn can be protected by a covering of wire mesh, or if the details of the structure permit, a band of sheet metal at the junction of the bins and structure may be all that is necessary; since rats do not gnaw the plane surfaces of wood but attack at the angles.

Old store houses infested with rats can be made to afford less harborage by removing the coiling and boxing around pipes.

Details for ratproofing a corn crib with wire mesh are shown on Design No. 521, a copy of which can be secured from the Division of Agricultural Engineering, Bureau of Public Roads, Washington, D. C. This method can be applied to other structures.

Farmers' Bulletins 1279, "Plain Concrete for Farm Use," and 1480, "Small Concrete Construction on the Farm," contain directions for using concrete and building concrete floors. Copies can be had on application to the Office of Publications, U. S. Department of Agriculture, Washington, D. C.

Where a dirt floor is desirable, galvanized wire cloth can be laid several inches below the surface as a barrier against rats. This method is sometimes practiced in poultry and hog houses and lots. The wire should be at least 12 or 14 gauge and 1/2 inch mesh. Before laying, the wire cloth should be coated with tar or asphaltic paint free from acid. A more lasting wire but also a more expensive one is a steel wire containing from 15 to 25% copper galvanized after weaving.

After a building is rat proofed precaution should not stop, because a rat will gain entrance through doors or windows left ajar for ventilation, frequently rats are brought in hidden in merchandise.

Rat proofing one building while an adjacent structure affords harborage will not eliminate the pest. Also the premises around the building must not afford hiding or feeding places such as boardwalks, piles of wood, brush or rubbish. An exposed garbage can, pig pen and other shelters for animals are frequented by hungry rats.

Rats must be exterminated from a neighborhood especially if closely built up before they can be entirely excluded from buildings.







The following literature has been published on the subject of rat extermination and inquiry as to its availability should be made of the Superintendent of Documents, Government Printing Office, Washington, D. C.

Farmers' Bulletin 1302, "How to Get Rid of Rats."  
 " " 670, "Field Mice as Farm and Orchard Pests."

Year Book Separate 482, "Mouse Plagues, Their Control and Prevention."

Year Book Separate 491, "Use of Poison for Destroying Noxious Animals."

Public Health Bulletin 103, "The Rat."

" " " 121, "Rodent Infestation and Rat Proofing Conditions in Massachusetts Seacoast Towns, New York City and Baltimore."

Public Health Reprint 86, "Rat Guard Used in Phillippine Islands."  
 " " " 122, "Rat Proofing." Its practical application in construction of buildings.  
 " " " 136, "Fumigation of Vessels for Destruction of Rats."  
 " " " 149, "Rat Proofing Municipal Sewer System."  
 " " " 167, "Relative Efficiency of Rat Traps." Type of trap which has proved most efficient in Manila.  
 " " " 259, "Rat Proofing Public Docks of New Orleans." Report on its possibilities and cost.  
 " " " 620, "Information Concerning Rat Surveys and Rat Proofing." A model ordinance designed to regulate building with reference to rat proofing.  
 " " " 655, "Guide to the Proper Rat Proofing of Buildings."







United States Department of Agriculture  
Bureau of Public Roads.

Thos. H. MacDonald, Chief of Bureau.

DITCHING WITH DYNAMITE.

To blast a ditch with dynamite, a number of small charges are placed in a series of holes -- along the center line if the ditch is to be less than fourteen feet wide and in two or more rows for wider ditches -- and exploded by one of two methods. In the "propagated" method the charges are so closely spaced that the detonation of one will explode the others. In the "electric" method each charge is connected to an electric battery and all are discharged simultaneously. The first method has the advantage of being usually the cheaper, but it can only be used in saturated soils; while with the electric method the charges are more sure to explode and therefore this method is sometimes the more economical one on account of the saving of time and labor.

There are two kinds of dynamite in general use for this purpose, the "straight" or "nitroglycerin", and the "extra" or "ammonia"; both are made in several strengths which are designated by percentages, as 40%, 60%, etc. Equal percentages indicate equal strengths as between the two kinds. For the propagated method, 50% (or stronger) straight dynamite must be used, while for the electric method the 40% strength of either kind is used. The "extra" dynamite is usually from one to two cents per pound cheaper than the same strength of straight dynamite, and the 40% strength of either kind is about the same amount cheaper than the 50% strength of the same kind.

While it is possible to use dynamite for ditching under almost any conditions, its profitable use is limited to small ditches and to soils other







than gravel and dry sand. The most economical size of dynamite ditch is one not much more than three feet deep and less than fourteen feet in top width; with greater depth or width the cost per cubic yard of excavation increases rapidly. Where conditions are such that the work is adapted to one of the several types of machine or power ditcher, it is not advisable to use dynamite; but it usually is much cheaper to blast ditches with dynamite than to dig them with hand labor. The ideal soil for dynamite ditching is a saturated, sedimentary soil that is firm but not as stiff as the hardest clays, and free from stumps and large roots. Many excellent ditches have been blasted under conditions quite different from these but as the conditions become less favorable the cost increases.

The size of the charges, their depth and distance apart, depend on the conditions present in each case. For each size of charge there is some definite depth at which a broad, U-shaped, clean-cut ditch will result, and which will give the maximum yardage per pound of explosive. When this depth is exceeded, loose dirt will be left on the sides of the ditch; and when the depth is too small the full power of the dynamite is not being used. The proper size and spacing of charges to give a clean-cut ditch of the desired depth must be determined experimentally for each set of conditions. This can best be done by firing a number of single charges, and when a size of charge is found which gives a smooth crater of the desired depth, a little less than the half-diameter of the bottom of the crater will be the proper distance between charges, for the electric method. The proper distance between charges for the propagated method can be found only by trial. For a ditch three feet deep, twelve feet wide on the top, in a saturated soil, it will be found that charges about as follows will be







required; for the propagated method, one stick of 50% straight dynamite, thirty inches deep and eighteen inches apart; for the electric method, two sticks of 40% extra dynamite, thirty inches deep and thirty inches apart.

The cost of ditch excavation by dynamite varies greatly. Under favorable conditions a pound of dynamite will blow out from one to two cubic yards of earth, making the cost for dynamite from 15 to 30 cents per cubic yard. Very little labor is required for such ditching. A gang of four men will load and shoot from 600 to 1000 lineal feet of single - row charges, per day. It is usually necessary to clean up the ditch by hand labor after blasting, by removing the debris and smoothing up the sides and bottom with shovels. This work should be done as soon as possible after the blasting, and if done promptly should not cost more than one cent per lineal foot of ditch.

The various manufacturers of high explosives have published a number of handbooks giving in detail directions for the handling, loading and firing of charges for ditching. This information can be obtained by addressing any of the following manufacturers:

Aetna Explosives Co., New York City, N. Y.  
Atlas Powder Company, Philadelphia, Pa.  
DuPont deNemours & Co., Wilmington, Del.  
Grasselli Powder Co., Cleveland, Ohio.  
Hercules Powder Co., Wilmington, Del.



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## DRAINING THROUGH WELLS

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Draining through wells, sometimes called "vertical drainage", refers to the method of disposing of drainage water through wells dug down to a porous soil layer or to an open rock formation. Sometimes such wells can be used advantageously to dispose of surplus water where outlets into natural or artificial watercourses are not easily accessible, or where accumulated water is held in depressions by a layer of tight soil or rock which does not permit the water to pass readily through it. The apparent simplicity of this method of draining makes it quite attractive to some landowners, but the fact is that the possibilities of drainage through such wells are limited.

In general, the method of vertical drainage consists in providing a channel for passing the water from the surface, through intervening impervious soil layers into an underlying reservoir. This reservoir may be formed either by rock openings or by an extensive body of coarse sand or gravel that is capable of taking up large volumes of water. It is only necessary, then, to dig, or drill a well down to this natural reservoir, and turn the drainage water into it, first having taken precautions to prevent the closing of the well by lining it properly and by providing an entrance for the water that will exclude trash and sediment. All this sounds very simple. The difficulty lies principally in the fact that the existence of the required underground reservoir is the exception rather than the rule, and there usually is no way to tell in advance whether such reservoir exists or whether its capacity is sufficient to be permanently effective.

In the limestone areas of the United States, particularly in Indiana, Kentucky, Tennessee, Virginia, West Virginia, and Alabama, "sink holes" are more or less common. Frequently drainage of considerable



Drainage Through Wells

Drainage through wells, sometimes called "vertical drainage", refers to the method of disposing of drainage water through wells that lead to a porous soil layer or to an open rock formation. Sometimes such wells can be used advantageously to dispose of surface water where surface water or artificial watercourses are not readily available, or where subsurface water is held in strata by a layer of light soil or rock which does not permit the water to pass readily through it. The apparent simplicity of this method of drainage makes it quite attractive to some landowners, but the fact is that the possibilities of drainage through wells are limited.

In general, the method of vertical drainage consists in providing a channel for passing the water from the surface, through intervening layers of soil or rock, into an underlying reservoir. This reservoir may be formed either by rock strata or by an extensive body of water, such as gravel that is capable of taking up large volumes of water. It is only necessary, then, to dig or drill a well down to this natural reservoir, and turn the drainage water into it. This having been done, the water will flow into the well by itself, and no further action is necessary to prevent the raising of the well by lifting it properly and by providing an entrance for the water that will enable it to flow out.

With this simple system, the difficulty lies primarily in the fact that the existence of the potential underground reservoir is the exception rather than the rule, and there usually is no way to tell in advance whether such reservoir exists or whether the capacity is sufficient to be permanently effective.

In the United States of this United States, particularly in the States of Maryland, Virginia, West Virginia, and Alabama, "sink holes" are more or less common. Frequently drainage of considerable



areas takes place naturally through these depressions, there being only a few feet of soil over the actual rock crevices; indeed these openings sometimes extend to the ground surface. Where such crevices can be reached without great expense they afford good outlet for drainage, and in the limestone areas therefore are found the best opportunities for vertical drainage that we have.

Drainage wells that depend for their efficiency upon the water capacity of underground sand or gravel layers will always be more or less uncertain except where experience with nearby wells discharging into the same reservoir has proved the latter's capacity. Even then the addition of more wells may prove the undoing of all. Often such wells give good service for a time, finally to become ineffective due to lack of capacity of the reservoir. If such reservoirs are known to have ultimate outlet as springs into streams or depressions, the probability of their utility for drainage purposes is increased.

#### Construction of Well.

Shallow wells, say not over 30 feet deep and penetrating only soil, may be dug or bored. If dug they are lined with rock or other suitable material. Shallow bored wells are constructed with the soil auger up to 7 inches in diameter. Such a well may be cased with ordinary drain tile or sewer pipe, the tiles being strung on a wire and lowered successively into place.

Deep, rock-penetrating wells are constructed with ordinary power-drilling machinery, iron or galvanized piping being used for casing down to rock. Such wells have been constructed to a depth of more than 300 feet, and usually are from 3 to 7 inches in diameter.

A very important feature of any drainage well is the device for preventing the entrance of trash and sediment which if allowed to enter



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would ultimately seal up the well and destroy its usefulness. Neglect in this respect has rendered many drainage wells worthless. Where the well is employed to remove only surface water, the casing may be extended nearly to the ground surface and the opening covered by a metal screen which in turn should be covered with broken stone or coarse gravel up to the ground surface. Frequent cleaning of this screen will of course be necessary.

Drainage wells sometimes are used as outlets for tile drains. In this case it is highly advisable to construct in the ground a box or cistern into which the tile discharge directly, and through the floor of which the well casing passes. This cistern usually is made about 6 feet deep and from 6 to 8 feet square, and is lined with masonry or concrete. The well casing extends from one to 3 feet above the floor of the cistern and is capped with a screen. Thus such sediment as is brought in settles to the bottom of the cistern, only the comparatively clear water entering the well proper. The screen prevents the entrance of floating trash. Such screens have varied all the way from ordinary kitchen crocks inverted over the 6 inch tile casing, to a rather elaborate commercial device constructed of cement. The object in all is the same -- to permit free entrance of water while excluding trash.

#### Causes of Failures.

Failures of drainage wells as a means of disposing of surplus water may be attributed principally to two causes: First, natural lack of capacity of the substrata to receive and dispose of the water; second, construction and maintenance faults that cause the wells to become obstructed with trash or sediment. Lack of natural capacity is a difficulty that cannot be overcome, and ordinarily it is only by costly experimentation that the true situation in this respect can be determined.



would ultimately seal up the well and destroy its usefulness. In this respect the treatment of the well is similar to that of the well in which is employed to remove only surface water, the danger may be extended nearly to the ground surface and the opening covered by a metal cap which in turn should be covered with certain stone or metal plates so as to prevent the ground surface. It is proposed to lay out this system with of course as necessary.

Drainage wells sometimes are used to surface for the drainage. In this case it is highly advisable to construct in the ground a line or system into which the like drainage directly, and through the filter at which the well casing passes. This drainage usually is made about 6 feet deep and from 6 to 8 feet square, and is lined with masonry or concrete. The well casing extends from one to 2 feet above the floor of the drainage and is capped with a screen. This such screen as is placed in relation to the bottom of the drainage, and the masonry is placed under the well. The screen prevents the entrance of floating trash. When necessary, water is pumped up the well from the bottom of the drainage through a float valve over the 6 inch pipe casing, as a matter of convenience, the device constructed at present. The object in all of the above is to provide free entrance of water to the existing well.

#### General Principles

Principles of drainage wells are a means of disposing of surface water may be attributed principally to two causes: First, natural, and of capacity of the subsurface to receive and dispose of the water; second, construction and maintenance of the well so as to become obstructed with material and prevent the water from entering. It is difficult to prevent the water from entering, and ultimately it is only by costly experimentation that the construction in this respect can be determined.



Failures due to trash and sediment can be largely prevented by proper precautions, such as screening against trash and providing a cistern for retaining the silt. It need hardly be said that even a well-constructed system will probably become ineffective unless periodically inspected and the accumulated silt and trash removed.

#### Should Drainage Wells be Used?

In answering this question, some figures obtained by a drainage engineer of the Department are of value. Seventy-three drainage wells of the shallow type were examined and the landowners interviewed. Practically all of these were equipped with the commercial "drain head". They were nearly all located in the North Central States, and had been installed for periods ranging from a few months to 6 years. Of the 73 landowners, 42 reported their wells as being unsatisfactory; 23 stated them to be of doubtful value; 8 were satisfied. Of the 23 such wells uncovered and examined by the engineer, none was seen actually to be taking in water, although in some there was evidence that water had at one time entered.

The power-drilled, rock-penetrating wells have generally proved more effective than have the shallow wells; and of those in the porous-limestone sections, when carefully located and properly constructed, perhaps 75 per cent have been successful. In parts of these areas only a casual inspection and the general knowledge of the local existence of caves and fissures in the limestone are sufficient to establish the practicability of vertical drainage in that immediate neighborhood.

The cost of successful drainage wells has not been low; on the contrary, for those examined it has ranged from \$90 to \$200 per acre drained by the wells. This indicates an average cost that is fully as high



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All of these were equipped with the commercial "drain heads". They were  
mostly all located in the North-Central States, and had been installed for  
periods ranging from a few months to 5 years. Of the 23 installations, 12  
reported their wells as being unsatisfactory; 11 stated them to be of  
doubtful value; 8 were satisfied. Of the 23 drain wells uncovered and  
examined by the engineer, none was seen actually to be leaking in water,  
although in some there was evidence that water had at one time entered.  
The poorly installed, non-permeating wells have apparently proved  
not effective; they leave the shallow wells; and of those in the better  
locations sections, when carefully located and properly constructed.  
Perhaps 15 per cent have been successful. In spite of these facts only a  
general impression and the general knowledge of the local conditions of  
land and location in the situation are sufficient to establish the  
possibility of vertical drainage in that immediate neighborhood.  
The cost of unsaturated drainage wells has not been low; on the  
contrary, for those examined it has ranged from \$30 to \$200 per well  
drained by the wells. This indicates an average cost that is fairly as high



as the average assessment would have been for outlets in organized drainage districts. The conclusion therefore seems justified that, excepting in those special cases where the feasibility of the method is obvious, one cannot afford to experiment with vertical drainage where a surface outlet can be obtained at a reasonable cost.



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in advance, the correct effect in agreement with vertical training  
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UNITED STATES DEPARTMENT OF AGRICULTURE  
Bureau of Public Roads  
Thos. H. MacDonald, Chief,

INSTRUCTIONS FOR THE  
CONSTRUCTION OF TILE DRAINS

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Prepared under the direction of  
S. H. McCrory, Chief, Division of Agricultural Engineering.

June 1922.



THE UNIVERSITY OF CHICAGO  
DIVISION OF PHYSICAL SCIENCES  
DEPARTMENT OF CHEMISTRY

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1955

BY J. H. HARRIS AND J. H. HARRIS  
DEPARTMENT OF CHEMISTRY, UNIVERSITY OF CHICAGO

1955



## INSTRUCTIONS FOR THE CONSTRUCTION OF TILE DRAINS.

Tools -- The tools most commonly used in trenching and laying tile are, tile spades, shovel, drain scoop, and tile hook (see fig. 1). The tile spades are of two kinds--solid and open--and are from 16 to 22 inches long, the 18 and 20-inch sizes being most used. The open spade is used in digging mucky or sticky soils. The shovel used is the ordinary long-handled, round-nosed type. The drain scoop is long-handled, semi-circular in shape, and made to fit the various sizes of tile up to 8 inches. The tile hook is made of  $\frac{1}{2}$  inch round iron--the long part being 9 inches and the short part 4 inches in length--fastened to an ordinary rake handle.

Establishing Grade -- When using inexperienced labor, probably the best method of establishing grade is that of gage and line. This method is illustrated in figure 2. The trench is marked out by stakes set 50 feet apart. At each 50-foot station there are two stakes, one with its top about level with the surface of the ground and known as a "grade hub", the other standing a foot or more above the ground and called a "guard stake". From the top of the grade hub all measurements are made. The guard stake locates and gives the number of the hub; upon it may be marked the required depth of the trench below the top of the hub. For measuring to the bottom of the trench a gage is used. This is merely a stick (usually about 1 by 2 inch) having a length somewhat more than the greatest depth of cut to be encountered. For ordinary farm tile work an even 6 feet is a good length.



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To dig the trench to the proper grade proceed as follows:  
Drive a strong stake upright near the hub and another on the opposite side of the trench as shown in figure 2. Place across the trench a bar with its top edge at a height above the hub equal to the difference between the length of the gage and the depth of cut as given by the engineer for that station. The cross bar should be set exactly level by the use of a small carpenter's level. A convenient way of fastening the cross bar to the uprights is by means of clamps as illustrated in figure 2. Set similar cross bars at three or more stations and over the center line of the trench, stretch a light, strong cord (preferably fish line) taut across the tops of the bars from one station to another. If the fall is uniform any error in establishing grade can be detected by sighting over the cross bars. The tile layer, by setting the gage on the trench bottom, can determine if the latter is at right grade by measuring to the cord which is of course, the length of the gage above grade and parallel with it. By frequently testing the trench bottom it can be dug to exact grade. The bottom of the gage must be kept clean as any adhering dirt will result in incorrect grade.

Figure 2 illustrates the various operations in establishing grade by the gage-and-line method. In this figure a cut of 3 feet 11 inches is indicated at the hub in the foreground. Subtracting this figure from the length of gage, say 6 feet, there remains 2 feet 1 inch. The top of the cross bar is therefore set at this distance above the hub. The gage in the foreground indicates that the trench has been dug to proper grade at that point. The other gage indicates



On the ground in the present position as follows:

There is a strong and high wall on the north and south on the

opposite side of the wall as shown in Figure 2. There across the

ground is a low wall on the top edge of the wall and the wall is

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that further digging is required, the amount being shown by the length of the gage extending above the cord.

Another method of obtaining proper grade, widely used by experienced tile layers, is as follows (see figure 3). Mark a 1 by 2-inch by 5-foot gage in feet and inches. Drive two iron or steel rods (about  $3/8$  inch) or stakes (about 2 by 2 inches) firmly on either side of the trench, one near the hub and the other about 3 feet from it on the opposite side of the trench. Measure up on the rod a distance from the hub equal to the difference between 5 feet and the cut indicated at that station. Stretch a white chalk-line level between the two rods at this elevation, which will then be 5 feet above the required bottom of the trench. Set similar targets at two or more other stations. The workman secures the proper grade by sighting over the top of the 5-foot gage and the lines. If these line up, the trench is at grade; if the top of the gage projects above the line of sight established by the targets, the trench is not deep enough; if the top of the gage drops below the line of sight, the trench is too deep. Usually it is more convenient to sight down the completed trench rather than up the trench. However, when starting from the outlet (as indicated in figure 3), or when passing a point where the grade changes, it is necessary to sight upstream until the first station is passed.

Trenching -- Trenching should always begin at the outlet and proceed upstream. For small tile, trenches are usually dug 10 to 15 inches wide, according to the depth, and with practically vertical sides. The trench is dug with a spade to within 1 or 2 inches of grade and then, with the tile scoop, the bottom is cleaned out to grade. Standing in



that further digging is required, the amount being shown by the length  
of the pipe extending above the curb.

Another method of obtaining proper grade, already used by

experienced this method, is as follows (see figure 3). First a 1 ft.

2-inch by 2-inch pipe is laid out in line. Then two lines are

laid (about 1/2 inch) or rather (about 2 or 3 inches) from the pipe

side of the trench, one from the top and the other about 3 feet from the

on the opposite side of the trench. Measure up on the top a distance

from the top equal to the difference between the level and the

desired at that station. Mark a white chalk-line level between the

two rods at this elevation, which will then be 3 feet above the

bottom of the trench. Set similar targets at two or more other stations

The workman follows the proper grade by sighting over the top of the

2-inch pipe and the line. It then runs up, the proper is a

It the top of the pipe projects above the line of sight established

by the targets, the trench is too deep enough at the top of the pipe

grade below the line of sight, the trench is too deep. Usually it is

more convenient to sight from the completed trench rather than up the

trench. However, when starting from the surface the method in figure

3), or when finding a point where the grade changes, it is necessary to

sight across from the first station to the second.

Remarks -- The trench should always begin at the surface and

proceed downward. For small pits, trenches are usually dug to a

depth of 3 feet, according to the depth, and with practically vertical sides.

The trench is dug with a shovel to within 1 or 2 inches of grade and then

with the side scoop, the bottom is cleaned out to grade. Working in



the trench the workman draws the scoop toward him, leaving the trench bottom smooth and rounded to fit the lower part of the tile. Care should be had not to excavate below grade.

Laying Tile. -- Tile laying, like trenching, should begin at the lower end or outlet and progress upstream. In placing tiles they should be turned until the ends fit together tightly. If a tile is crooked and the ends irregular it should be turned until it fits tightly at the top, the open space being left at the bottom. Where, owing to irregular ends, a crack or opening of  $\frac{1}{4}$  inch or more must be left at the top or sides, it should be covered with pieces of broken tile or, in some sandy soils, with cement mortar.

If the trench has been dug below grade in dry material, the bottom can be built up to grade with moist earth, well tamped. In a wet, soft trench it may be advisable to lay the tile on plank bedded at grade. Where wet, fine sand or sandy loam is encountered it is necessary to prevent the material from washing into the tile through the joints. This can be done by tamping clay firmly around the joints or by wrapping them with cloth or tar paper. In laying tile through quicksand it is well to have the assistance of one experienced in such work,

Tile up to 6 inches in diameter can be laid either with a tile hook or by the man who is finishing the trench with the tile scoop. It has been found that with unskilled labor the best results are obtained if the man using the tile scoop works backward up the trench, laying the tile as fast as he finishes the grade. All tile that are cracked, soft, or poorly-shaped should be rejected, but these discarded tile are not wasted as it is necessary to have broken tile to patch junctions and poor joints. It is very important that the tile



The present and future of the world are in the hands of the people. The people are the only power that can bring about a new world. The people are the only power that can bring about a new world.

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be laid and "blinded" as soon as the trench is completed to grade. This is necessary as caving of the banks and softening of the bottom may occur. The end of the tile line should be closed whenever the workmen leave the job; and when completed, each line should be closed at its upper end by a brick or piece of broken tile.

Junctions and Curves. -- Junctions should be made by Y's, not by T's nor elbows. Practically all tile factories now make junction tile and these should be obtained if possible. If Y's can not be obtained, junctions can be made by cutting and fitting together straight tile. When this is done care must be taken to prevent the branch tile from projecting into the main. Unless the lack of fall prevents, there should be a drop from the branch into the main. This effect can be obtained by turning the Y slightly in its bed so as to elevate the branch.

Changes of direction should be made by curves and not be sharp angles. These curves should be regular, with the outsides of the joints covered by pieces of broken tile or, for a sandy soil, the ends of the tiles can be chipped off on the insides of curves with a hammer or by catching the tile between the jaws of a monkey wrench and bearing down on the handle.

Blinding Tile -- The tile should be covered the same day as laid with loose earth to a depth of 4 to 6 inches in order to hold them in place. This should be done carefully in order not to displace the tile.

Backfilling Trenches -- Trenches should be filled soon after the tile is laid. For this purpose a plow can be used with two mules, one on either side of the trench, attached to a long evener.



is said to be "strong" as soon as the stomach is subjected to pressure.  
This is necessary as a sign of the stomach and contents of the stomach  
may occur. The rest of the life should be spent in the  
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Indigestion and Vomiting -- Indigestion should be given by the  
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obtained by eating the food in the food as to eat the food.



One side is plowed while going in one direction and the other side on the return trip; usually two rounds of the plow are sufficient to backfill a ditch. A scraper made from 2 by 12-inch lumber, 4 feet long, can be used to a good advantage in many cases. The mules in this case work at right angles to the trench, scraping in the earth piled on the bank. If this method of backfilling is to be used, it is advisable to throw all the earth dug from the trench on one side. Road-grading machines can also be used for backfilling trenches.

The Outlet -- The outlet should be protected by a brick, stone, or concrete headwall. If not more than 4 feet high the headwall should be 1 foot thick and extend from the ground surface to a depth of at least 1 foot below the bottom of the ditch in front of the headwall. For higher walls the thickness should be increased accordingly. A typical brick headwall is shown in figure 4. Tile outlets often give considerable trouble by washing out and caving unless protected in a substantial manner. The joints of the first 10 feet next to the headwall should be cemented. Where freezing occurs, the first 10 feet of drain should be of vitrified pipe or second-grade sewer pipe.

Burrowing animals, such as muskrats, rabbits, etc., often cause trouble by entering drains at the outlet and building nests, thus obstructing the drain. Where trouble from this source is likely to occur, it may be well to attach an automatic flap at the end of the drain. A screen permanently fixed over the outlet sometimes gives trouble by catching matter washed down the drain, especially in systems where surface inlets are used. A design for a hanging screen is shown in figure 4. Ordinarily, surface water which follows the depression







over the tile line should be diverted so as not to discharge over or around the headwall.

Surface Inlets and Silt Wells. -- The purpose of the surface inlet is to admit surface water directly into the drain. The office of the silt well is to catch and retain any silt suspended in the water. These two devices are often combined in one structure. The surface water enters through the top, while the drain water enters through the tile at one side and flows out at the other. Two or more lengths of sewer pipe set on end, with connections, make a satisfactory surface inlet (see Fig. 5). In the top of the pipe should be placed an iron grating which may be covered by a pile of broken brick or small stones to act as a coarse filter. From time to time the brick or stone should be rearranged and the silt removed from the bottom of the catch basin. A combined surface inlet and silt well, to be built of concrete, is also shown in figure 5. If only a small amount of surface water is to be handled, a satisfactory inlet can be made by filling a section of the trench with broken brick or tile, or with gravel. Figure 5 also shows an inlet of this type. The use of surface inlets will greatly increase the effectiveness of the drains, especially in heavy clay soil where the percolation through the ground to the tile is naturally slow.

Records and Markers. -- A permanent record should be kept of the locations and depths of all drains. To this end all maps, plans, and profiles of the system, as built, should be preserved. Wherever a tile line crosses or ends at a fence, farm road, or other permanent line, iron stakes or pieces of pipe should be driven over the tile line in order that the latter may be easily located. The importance of this will be seen when it is desired to extend or repair



over the side line should be situated as far as possible from the  
main line of the main.

General Principles and Rules

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drains, or add branches.

Correct levels necessary. -- Attention is called to the importance of having no sags in a completed tile drain. Any depression is likely to cause a settling of silt in the tile which will result in partial or even total obstruction of the drain. Where the available fall is slight, the determination of the levels upon which the construction work is based must be accurately done. For this reason it is advised that these preliminary levels be determined with an engineer's level where this is practicable, and that one of the foregoing methods of establishing grade be used. The less the available fall the greater the necessity of accurate work. When the fall is 3 inches or more per hundred feet, fairly good results can be had by establishing the tile grades with an "A" frame used in connection with a carpenter's level. Such a device is shown in figure 6. The legs, ab and bc, may be of 1 by 4-inch lumber, 12 feet long. The distance ac is 16 feet 6 inches (1 rod). The brace upon which the level rests should be absolutely straight and so set that when the legs of the frame rest on a perfectly level surface the level bubble is at the center of the tube. Any desired fall can be obtained with this device by mailing a block upon the bottom of one leg. Thus a 1-inch block, as shown in figure 6, would give a fall of 1 inch per rod. Care must be had to see that no dirt adheres to the bottoms of the legs as this will seriously affect the grade.







Fig. 1  
Ditching Tools

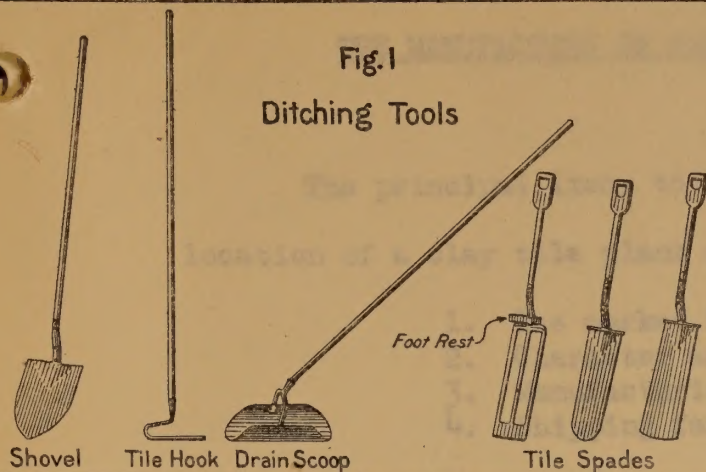


Fig. 2. Establishing Grade  
Gage and Line Method

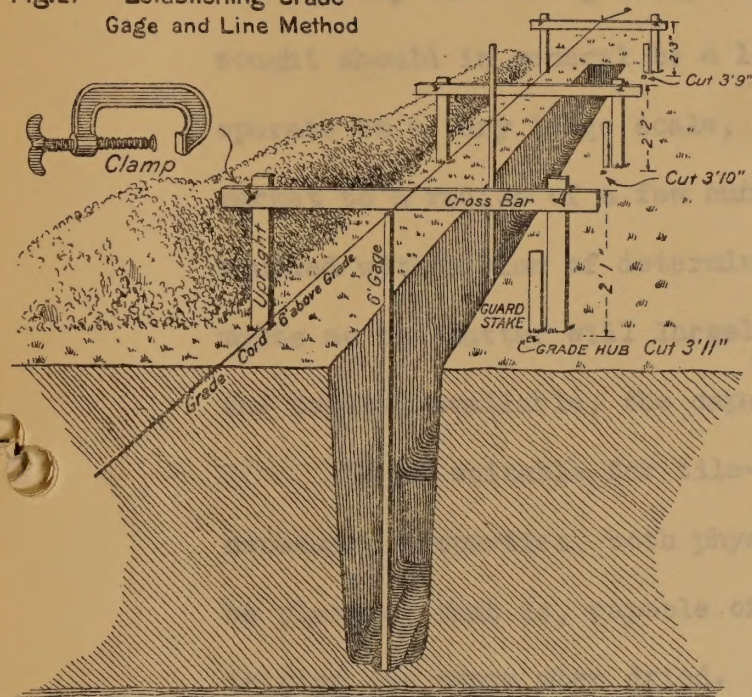


Fig. 3. Establishing Grade  
Gage and Sighting Method  
Starting a Trench

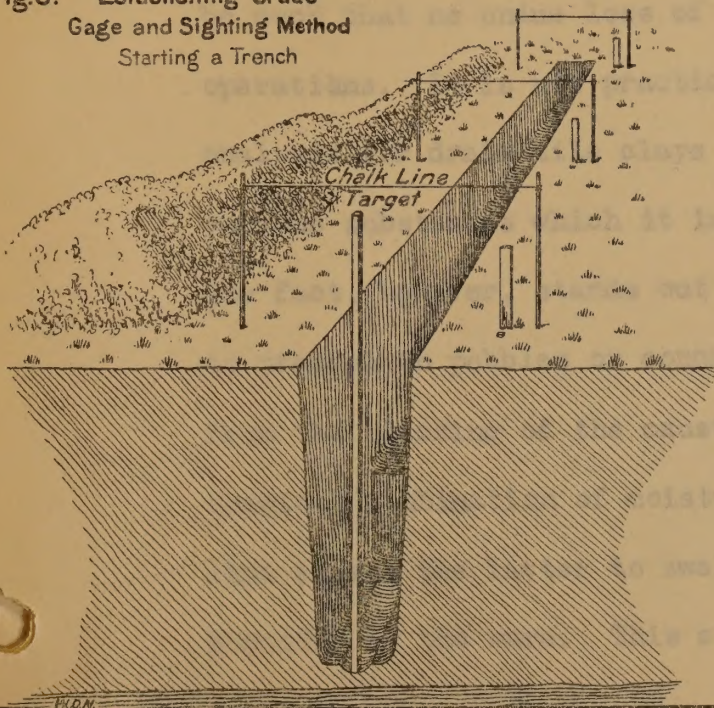
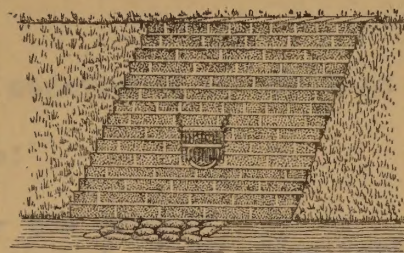
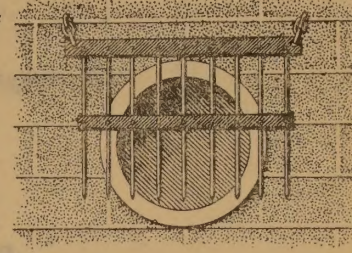


Fig. 4



Headwall for Tile Outlet



Screen Gate  
 $\frac{1}{2}$ " Rods spaced  $\frac{1}{2}$ " between centers

Fig. 5. SURFACE INLETS AND SILT WELLS

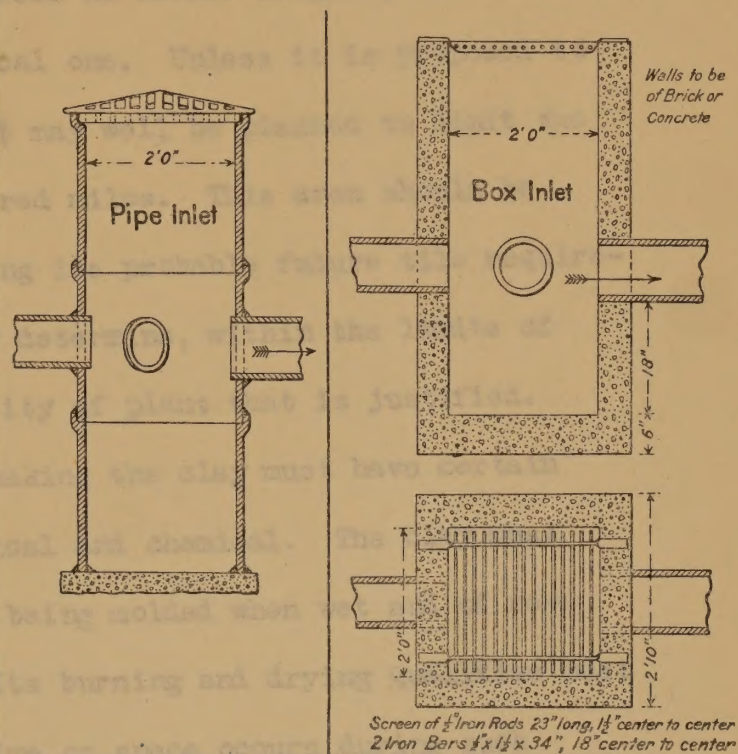


Fig. 6  
"A" Frame Level

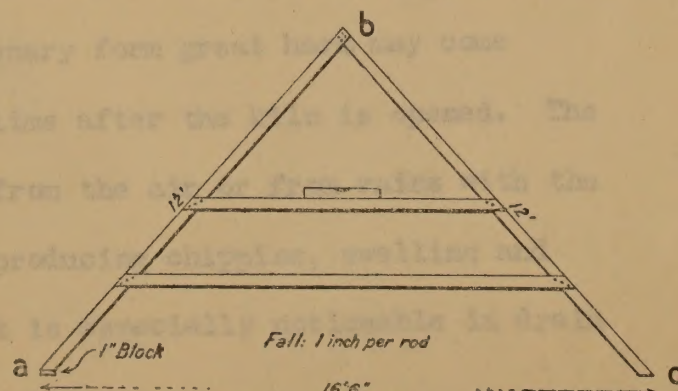




Fig. 1  
Ditching Tools



Fig. 2  
Establishing Grade  
Cuts and Line Method

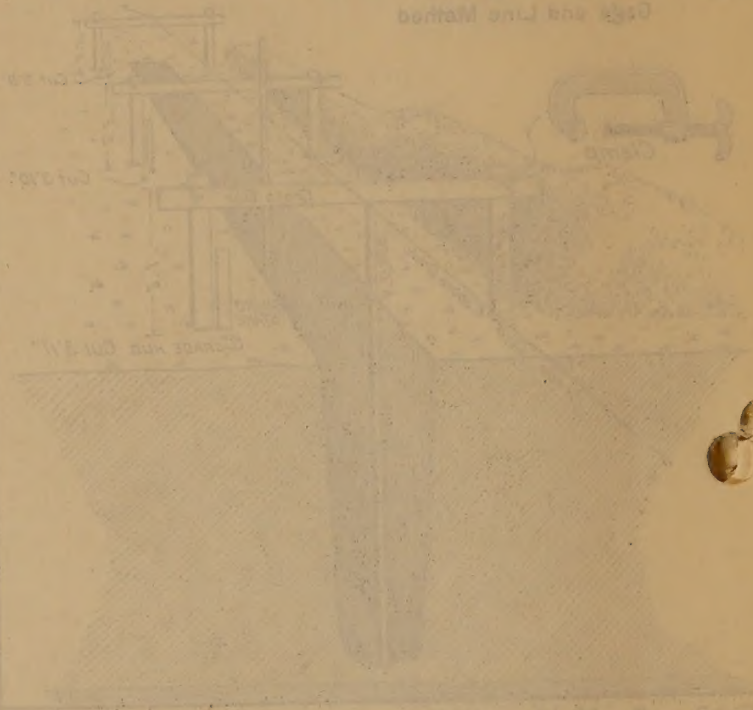


Fig. 3  
Establishing Grade  
Cuts and Sighting Method  
Starting a Trench

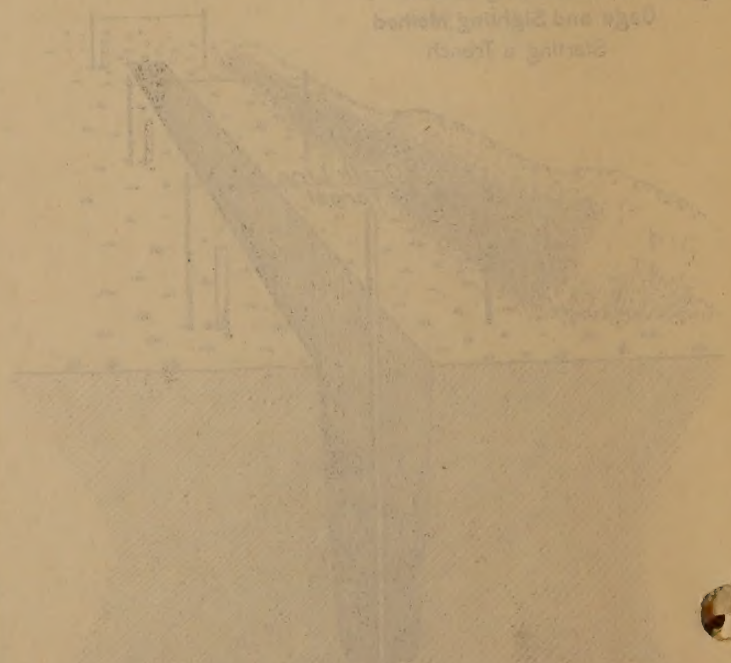


Fig. 4

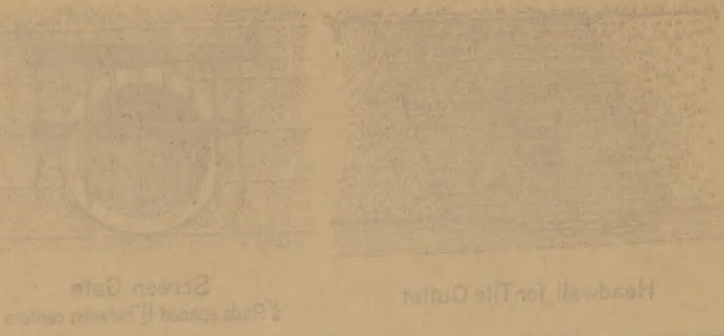


Fig. 5  
SURFACE INLETS AND SILT WELLS

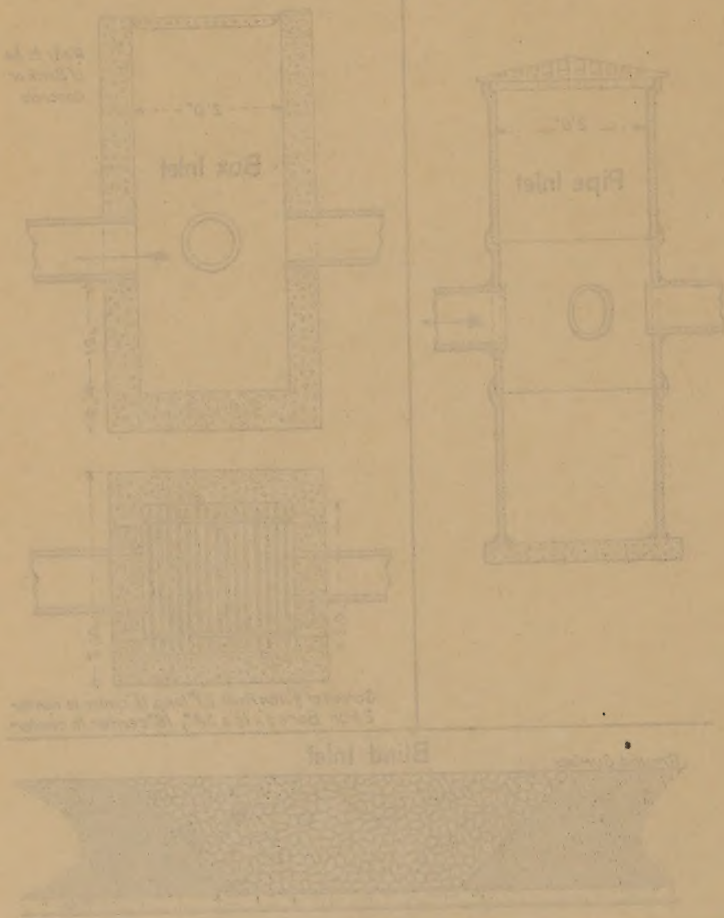


Fig. 6  
A. Frame Level





65

## THE MANUFACTURE OF CLAY DRAIN TILE

The principal items to be considered in deciding upon the location of a clay tile plant are:

1. The market for the product
2. Character and amount of clay available
3. Manufacturing conditions - fuel, water, labor, etc.
4. Shipping facilities.

Clay tile being bulky as well as rather fragile, the market sought should in general be a local one. Unless it is proposed to operate on a very large scale, it may well be planned to limit the market to a radius of a few hundred miles. This area should be studied with a view of determining its probable future tile requirements as the latter will largely determine, within the limits of the capital available, the capacity of plant that is justified.

To be suitable for tile-making the clay must have certain necessary properties, both physical and chemical. The clay must be plastic, that is, capable of being molded when wet and of retaining its shape when dried. Its burning and drying qualities must be such that no undue loss of time or space occurs during such operations. It is not practicable to assign any standard chemical analysis for drain-tile clays or to set any limits to the amounts of various substances which it is allowable for such clays to contain. One fact, however, stands out distinctly and that is that where lime is present in pebbles or concretionary form great harm may come from the slacking of the caustic lime after the kiln is opened. The chemical combination of moisture from the air or from rains with the lime causes the latter to swell, producing chipping, swelling and bursting of the ware. This effect is especially noticeable in drain



## THE MANUFACTURE OF CLAY BRICKS

The principal items to be considered in building a brick plant are:

1. Location of a clay site and

2. The market for the product
3. Character and amount of clay available
4. Manufacturing conditions - fuel, water, labor, etc.
5. Shipping facilities

Clay site being fully as well as other factors, the market

should be given as much consideration as the clay site. Unless it is possible to

operate on a very large scale, it may well be planned to limit the

market to a radius of a few hundred miles. This area should be

studied with a view of determining the probable future of the region

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various substances which it is allowable for such clay to contain.

One fact, however, stands out distinctly and that is that where lime

is present in bricks or concrete, form great harm may come

from the blocking of the concrete lines after the brick is opened. The

chemical composition of materials from the air or from rain with the

lime causes the latter to swell, producing shrinkage, swelling and

bursting of the mass. This effect is especially noticeable in bricks



tile because of the thinness of the walls. The presence, therefore, of any considerable amount of lime in any form in drain tile clays is undesirable.

The most reliable method of determining the value of a clay for manufacturing purposes is by the actual making of sample pieces of ware in a manufacturing plant under conditions which will be met in the commercial manufacture of the tile. In making such tests great care should be taken to insure that the samples are representative of each portion of the clay bed. Several pieces of the ware should be molded with various percentages of water and the time of drying and the drying shrinkage and breakage should be noted. Each set of samples should be burned to at least three temperatures and the porosity, hardness shrinkage and color should be examined at each temperature. Any indication of unusual qualities must be run down and fully investigated. These tests should be made by a competent and disinterested ceramic engineer who can correctly read the meaning of the various phenomena which may occur. The initial cost of a clay working plant is so high that no reasonable expense should be spared that will establish the suitability of the clay and determine the right treatment of it.

If the report of the ceramic engineer is favorable the next important step is to have a complete survey made of the deposit. A topographic map of the area should be made and the land divided into squares of from 50 to 200 feet in dimension. Borings should be made at the corners of the squares to determine the thickness of the clay deposit. The thicker the clay the shorter should be the sides of the squares. In soft clays the borings can be made with an ordinary soil



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auger, but for shales and for clays in which there is a stratum of hard rock some kind of drill is required. In making these borings particular attention should be given to the thickness and character of the overburden as it has a direct bearing upon the cost of working the clay deposit.

There has been a marked preference among the buyers of drain tile for ware of a dark -red color, due no doubt to the general idea that the darker the color of the tile the better it has been burned and consequently the better its quality. The red color of the burned clay is generally due to the presence of ferric oxide in the clay and where this substance is present the more the tile is burned the darker the tile will be. It does not follow however that light red, yellow, or salmon color tile have not been sufficiently burned, for the light color may be due merely to the absence of ferric oxide or to some neutralizing agent. However, from the manufacturer's point of view a clay that will burn to a good red color is to be preferred until the buyers have become more thoroughly informed as to the reliable qualities of the lighter-colored tile.

The prevailing manufacturing conditions in the proposed locality must be carefully investigated before the value of a clay deposit can be determined. These conditions include such items as fuel, water and labor. As the operating cost of making tile drains is divided almost equally between labor and fuel, the cost of these two items is of great importance. It is seldom that fuel can be obtained from mines in the vicinity of the clay, so that the cost of fuel is largely dependent upon the freight rates and the plant facilities for handling it. The fuel in most common use is coal although producer



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gas and crude oil are used in some of the larger plants.

Like any other plant a clay factory must have plenty of good water. Water free from scale-forming impurities, and from chemicals that might affect the quality of the ware, is a prime necessity for a clay plant.

It is generally necessary to locate a plant on a railroad siding, or on a waterway. Drain tile are so bulky that handling is very expensive, and the loss from breakage is large, so that handling of the finished product should be avoided as much as possible. When locating a plant it is often necessary to choose between building it close to the clay bed and constructing a spur track to the railroad, or building on an existing siding and hauling the clay to the factory. In such cases it is generally advisable to build the siding, for while the initial expense will be greater it usually will be cheaper in the end than to haul the clay to the plant on the siding. Wherever possible the plant should be located below the level of the clay bank, so that gravity may be used to bring the clay from the pit to the plant. The location of the plant on a higher level than the pit is economical only when it serves to bring the clay to a suitable elevation for railroad shipping of the tile.

The economical minimum size of a clay-tile plant cannot be stated, for the returns which may be earned by a small, two-kiln plant, owned and operated at odd times by a farmer or small business man, while entirely satisfactory to that particular owner might not prove attractive to another. A plant with an artificial drier designed to operate the year around should have a capacity of at







least 15,000 feet of 4-inch tile a day. A plant of this capacity would use about 50 tons of clay per day, or in a year of 300 working days 15,000 tons of clay would be required. As the life of the machinery and plant is about 20 years at least 300,000 tons of clay should be available.

At present prices of labor and material it would not be advisable to attempt the construction and operation of such a plant on a capital of less than \$50,000.

The development of every clay bed should stand on its own merits; it must be a good proposition from both the technical and the economic standpoints. If it is not a good proposition from these standpoints the clay had better be left undeveloped.

March, 1921.



... 12,000 tons of steel would be required. As the life of the machinery  
and plant is about 20 years it would cost 120,000 tons of steel  
to be available.

At present prices of labor and material it would not be  
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March 1911.



*20 Grain drill  
See 70-  
Zer. 70-  
united  
see 70-10*

UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF AGRICULTURAL ENGINEERING  
Division of Mechanical Equipment

Information Series No. 69

October, 1935.

(Nos. 69 and 70 supersede No. 53, Corn planters and grain drills.)

HISTORY OF CORN PLANTERSCompiled by Lillian Church, Senior Clerk  
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## Primitive planting method

Butterworth (4, p.5 1/) states that "Pliny says the Romans sowed their corn with as much care as they raised their armies: that Columbus found the natives of the West Indies using bread of maize: that Humboldt says that the cultivation of maize was introduced into Mexico in 666(A.D.) by the Toltecs: that when Capt. John Smith visited Virginia in 1609, in writing of the Indians, he says:- 'The greatest labor they take is in planting corn.'"

The growing of corn by the Indians in the very early days, and by the early English settlers is interesting, especially when compared with methods and equipment used at the present time. Bidwell and Falconer (2, pp.10-12) cite Governor John Winthrop, Jr. of Connecticut, as authority for the following statement:- "It (maize or corn) is planted between the middle of March and the beginning of June, but most commonly from the middle of April to middle of May. Some of the Indians take the time of the coming up of a fish, called Aloofes, into the Rivers; others of the budding of some trees. \*\*\*\*\* "The manner of planting is in rows, at equal distance every way, about 5 or 6 feet. They open the earth with the hoe (hoe), taking away the surface 3 or 4 inches deep, and the breadth of the hoe, and so throw in 4 or 5 granes (kernels) a little distant one from another, and cover them with earth. If two or three grow, it may do well. For some of them are usually destroyed by birds or mouse-squirrels. The corn grown up an hands length, they cut up the weeds, and loosen the earth about it with a broad hoe; repeating this labor, as the weeds grow. When the stalk begins to grow high, they draw a little earth about it; and upon the putting forth of the ear, so much, as to make a little hill, like a hop-hill. After this they have no other business about it, till harvest. \*\*\*\*\* Where the ground is bad or worn out, the Indians used to put two or three of the forementioned fishes under or adjacent to each corn-hill, whereby they had many times a crop double to what the ground would otherwise have produced. \*\*\*\*\* The English settlers in Connecticut before 1678 had introduced the use of the plough in cultivating maize." Winthrop added the following to his description of Indian agriculture: "The English have now taken to a better way of planting by the help of the plough; in this manner; in the planting time they plough single furrows through the whole field, 1/ Figures in parenthesis refer to references cited at end of article. -----



about 6 feet distant, more or less, as they see convenient. To these they plough other across at the same distance. Where those meet they throw in the corn, and cover it either with the hoe or by running another furrow with the plough. When the weeds begin to overtop the corn, then they plough over the rest of the field between the planted furrows, and so turn in the weeds. This is repeated once, when they begin to hill the corn with the hoe; and so the ground is better loosened than with the hoe, and the roots of the corn have more liberty to spread. Where any weeds escape the plough, they use the hoe.

"Among the hills of the corn were planted beans and pumpkins, after the multiple-cropping system of the Indians. The stalks served as poles for the beans to climb upon. The importance of corn is shown by its early acceptance as a payment in kind for taxes. Corn seems to have served in all the colonies as a preliminary crop before other grains.

According to the United States Department of Agriculture (10, pp. 331-332) "In the earlier years the plow and harrow of that period were used; the check rows were marked with the shovel plow; the seed was dropped by hand from a bucket or pouch carried by the farmer, and covered with a hoe."

In the Report of the Commissioner of Agriculture for 1870, (9, pp. 400-401) it is stated that "In the cultivation of corn and other cereals in this country, in the earlier times, the condition of the newly cleared land precluded the employment of machinery in the planting and sowing of seeds; and hence corn was planted by hand, and wheat and other small grains were sown broadcast. Machinery could not have been made available to any great extent for this purpose, in consequence of the presence of roots and stumps of trees of the primitive forests; and it was not until the lands of the New England, Southern and Middle States had become cultivated, and immigration extended to the prairies of the West, that a necessity for this class of agricultural machinery was felt."

Crampton (5) relates that "In early days corn was planted in single rows by hand, by hand planters, or by some crude one-horse machine. In some places where small fields or clearings are planted, these methods are still employed. With the opening of the prairies of the great West, a more rapid method became necessary. In addition it became important to plant in hills so that the corn could be cultivated both ways, thereby reducing the labor of weeding to a minimum."

Fowler (7, p.355) states "Corn planters are strictly an American invention. Several patents on seeding machines were issued by the United States Patent Office from 1799 down to 1836, when the records were destroyed by fire, and some one or more may have been granted for putting seed corn into the ground. Afterwards other patents were granted covering various types, and improvements in hand and horse planters."

According to Bidwell and Falconer (2, p.381) "Whatever the degree of development in agricultural machinery prior to 1840, however, it was only a beginning when compared with the improvement and the general adop-



tion of new machinery which took place during the next two decades. In 1840 \*\*\*\*\* Corn was planted by hand, and cultivated with the plow, or, in the East, with a crude and more or less unsatisfactory cultivator. \*\*\*\*\* Farm machinery was still largely the product of the farm or local blacksmith shop. \*\*\*\*\* The scarcity of labor and the expansion of agricultural production into the prairie region stimulated the rapid development and introduction of improved agricultural machinery. The improvement along these lines which had been made before 1840 has been summarized by one writer as follows:-

"The disparity between old and new implements of culture is great, not only in the time employed, but in the manner in which they do their work, and in the power required to perform it. The old plow required a four-cattle team, and two hands, to manage it, and the work ordinarily was but half executed. The improved plow is generally propelled by two cattle, requires but one man to manage it, and, when properly governed, performs thorough work. Harrows and other implements have undergone a like movement. Besides, new implements, which greatly economize the labor of tillage, are coming into use, as the roller, cultivator, drill-barrow, etc.; so that a farm may now be worked with half the expense of labor that it was wont to be worked forty years ago, and may be better worked withal. \*\*\*\*\*

"The corn crop of 1840 was planted with the hoe, the plow or the ax. \*\*\*\*\* Hand planters and drills, it is true, were used to some extent in the East, but there was as yet no satisfactory machine for the planting of corn. During the fifties corn planters came rapidly into use, and by 1860 a large portion of the corn crop of the West was planted by one-row and two-row planters, hill planters and drill planters. \*\*\*\*\* The Ohio farmer of 1860 who adopted the improved methods of production then available could probably produce his crops with two-thirds the labor required in 1840."

#### Hand planters

In the Report of the Commissioner of Agriculture for 1869, (9, pp. 324-325) it is stated:- "Fifteen years ago there were but four patented hand planters; today there are over a hundred. During this period our inventors have been active. \*\*\*\*\* Our inventors have generally followed two well known styles of hand planters. The first and most favored is that exhibited in the patent of D.W. Hughes, which patent has just expired, and is therefore public property. In this invention there are provided two legs, pivoted together like the divisions of a candle-snuffer, the lower end or point of which is intended to be thrust into the ground to form an opening for the seed, the upper end being provided with a pair of handles. To the outside of one of the legs is securely affixed a seed box, into which extends a seed slide, which is connected to the other leg. In operation, the lower end of the planter is thrust into the ground; the handles are then brought together, which enlarges the opening in the soil, and at the same time draws out the seed slide, and with it a charge of grain, which drops into the opening. The planter is then withdrawn, and the seed covered with soil thrown upon it, and pressed down by the foot of the operator.



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"The corn crop of 1840 was planted with the hoe, the plow or the ax. \*\*\*\*\* Hand planters and drills, it is true, were used to some extent in the East, but there was as yet no satisfactory machine for the planting of corn. During the fifties corn planters came rapidly into use, and by 1860 a large portion of the corn crop of the West was planted by one-row and two-row planters, hill planters and drill planters. \*\*\*\*\* The Ohio farmer of 1860 who adopted the improved methods of production then available could probably produce his crops with two-thirds the labor required in 1840."

#### Hand planters

In the Report of the Commissioner of Agriculture for 1869, (9, pp. 324-325) it is stated:- "Fifteen years ago there were but four patented hand planters; today there are over a hundred. During this period our inventors have been active. \*\*\*\*\* Our inventors have generally followed two well known styles of hand planters. The first and most favored is that exhibited in the patent of D.W. Hughes, which patent has just expired, and is therefore public property. In this invention there are provided two legs, pivoted together like the divisions of a candle-snuffer, the lower end or point of which is intended to be thrust into the ground to form an opening for the seed, the upper end being provided with a pair of handles. To the outside of one of the legs is securely affixed a seed box, into which extends a seed slide, which is connected to the other leg. In operation, the lower end of the planter is thrust into the ground; the handles are then brought together, which enlarges the opening in the soil, and at the same time draws out the seed slide, and with it a charge of grain, which drops into the opening. The planter is then withdrawn, and the seed covered with soil thrown upon it, and pressed down by the foot of the operator.



"The first machines used for seeding were universal in the respect that they were used for the smaller grains as well as corn." (6, p.120) One of the early patents for a corn planter was issued to D.S. Rockwell, on March 12, 1839. This machine is described by Audroy (1, p. 30) as "a planter with four wheels of equal size and two seed-boxes, and was intended to plant two rows. Furrows were opened for each row by a peculiarly shaped shovel, behind which the seed was dropped between two diagonally set blades, the combination of shovel and blades being faintly suggestive of the modern shoe. The rear wheel, set behind the blades, covered the corn and packed the earth as in the modern planter. The seed was dropped from the hopper by a device consisting of the slides placed above and below the partition, and operated upon by means of a toothed segment and pinion, arranged substantially as set forth, and set in motion by one of the bearing wheels."

"The next patent, to G. Mottmiller, of Columbus, Ohio, Sept. 1, 1843, covered a frame jointed to the axle, but had other features not consistent with a practical planter. E. Wood's invention, patented January 10, 1845, was intended for drilling two rows of potatoes, but had many features of a successful corn planter. Edward Wicks, of Bart Township, Pa. patented March 26, 1850, a planting cylinder containing cells or cavities that could be enlarged or diminished as might be required. D.B. Rhodes, of Concord, N.Y. patented in December, 1850, a double-row planter in which the hopper had two sliding bottoms arranged to measure and drop the seed. In C. Van Every's planter, one wheel, about four feet in height, had an intermittent gear with cogs at three points on its periphery to operate the dropping device, so as to plant three hills with each revolution of the wheel." "It will be observed that all the inventions mentioned thus far had automatic dropping devices, but in the next patent, to M. Corey, of Jerseyville, Illinois, October 28, 1851, there was a claim covering an indicator to point out 'the place where corn had been planted', suggestive of operating the dropper by hand. The next and last patent previous to the appearance of a generally successful planter, was granted to H. Vermillion, of Rising Sun, Indiana, November 2, 1852, and covered a peculiar distributing device. (1, p.30)

"The aim of these early inventors was evidently to produce an automatic planter, and nothing practical came of their efforts because the real need of the western farmer was a planter that would place the hills in check, so the corn could be plowed both ways. A device for dropping the corn by hand or in some way under the direct control of the operator must be combined with means for opening the furrow and covering the corn. This was done by George W. Brown, of Tylersville (later of Galosburg), Illinois, whose first patent was issued August 2, 1853, but afterward reissued February 16, 1858, and again reissued September 11, 1860. It is said that Mr. Brown used his planter successfully as early as May, 1851. In his first patent in 1853 he claimed: 'The oscillating horizontal wheels or distributors, in the bottom of the hopper, having slots and holes of various sizes, in combination with stationary caps and pins, for the discharge of different kinds and quantities of seeds. Also, the arrangement of covering rollers, mounted as described, and performing the purposes of covering the seed, elevating the cutters in turning around,



and in adjusting them to different depths.' As reissued in 1858 the patent had only one claim: 'A shoe for opening a furrow, which has a convex edge in front and a seed-tube in its rear end, so that it may cut through any grass, open out a furrow and hold it open until the seeds are deposited in it, substantially as herein set forth.' (1, p.31)

"In the reissue of September 11, 1860, all the new features in Mr. Brown's planter were covered in five divisions or claims. Briefly stated, the first division covered the frame, supported in front on not less than two runners or shoes with upward inclining edges, and the rear part supported on not less than two wheels, the latter being arranged to follow the former. The second division covered the shoe or runner, edged and curved upward in front so as to climb, cut or break through obstacles, and widening toward its rear end so as to open a furrow for the seed; and also made long enough to furnish support to the framework. The third division covered the hinged joint between tongue and rear of the machine, so that one part of the frame might be raised, lowered, adjusted, or supported on the other part. The fourth division claimed the operation by hand of the dropping mechanism, by an attendant riding on the machine, in position to see the marks for the corn and to operate in conformity therewith; also the lever and its arrangement by which the driver could raise the framework and seeding devices carried thereon, to aid the machine in passing over obstacles and in turning around. The fifth division claimed in combination with runners and covering wheels, a pair of auxiliary wheels and an axle for the double purpose of taking the weight off the runners and covering wheels, and for affording means for converting the machine from a planter operated by hand to an automatic seed-sower; and also hanging the axle of auxiliary wheels in adjustable arms or levers so that more or less of the weight of the machine might be placed upon said auxiliary wheels. (1, p.31)

"Other patents were granted about this time. One to L. Caswell, of Harrison, Maine, August 1, 1853, covered an adjustable axle; another to E. Marshall, of Clinton, New Jersey, April 11, 1854, was on automatic dropping devices, and still another to M. Ward, of Owego, New York, March 27, 1855, covered a slotted adjustable share and short compressing blocks on the periphery of the wheel, to press the earth over the seed and at the same time mark the hill. (1, pp.31-32)

"George W. Brown's second patent was issued May 8, 1855, and claimed: 'In combination with the hoppers and their semirotating plates, the runners, with their valves, and their adjustment by means of levers and cams, and the driver's weight, for the purpose of carrying and dropping seeds by each vibration of the lever, and to regulate the depth of planting as described. (1, p.32)

"This second patent of Mr. Brown's was reissued November 10, 1857, and again December 11, 1860. As reissued it covered: Placing seats of driver and dropper so that one balanced the other; making driver's seat adjustable so he could put more or less of his weight on the seeding apparatus, and thus regulate the depth; hanging the seeding apparatus on hinged joints so it could be raised out of the ground and carried on the wheels and tongue; a stop for preventing rear part of frame from descend-



ing too low when the forward part was raised and carried; and finally, an improvement in dropping device, by which, with one lever, the seed passages could be opened and closed at regular intervals to pass measured quantities. (1, p.32)

### Markers

"The first patent on a marker was granted to E. McCormick, October 16, 1855, for a device projecting from the end of the axle. F. Goodwin, of Astoria, New York, March 3, 1857, showed in his patent the first marker that could be changed from one side to the other, but did not make any claim on it, and Kuschke and Merkel, of St. Louis, in their patent of May 26, 1857, made no claim for their markers, one on each side of the planter, arranged so as to be folded over the planter when not in use. The marker as used to-day (1894) was shown in the invention of Jarvis Case, of La Fayette, Indiana, whose patent, under date of December 1, 1857, showed a marker having a double edged shoe, and hinged so that it could be turned over to mark on either side, or be raised clear of the ground in turning."

Blackburn (3, pp. 707, 731) gives a somewhat fuller description of the McCormick invention. "In 1855 E. McCormick secured a patent for a device projecting from the axle for the purpose of marking the next row. The contrivance consisted of a wooden shaft attached to the axle, and having on the free end a small block of wood which would scratch a furrow at a sufficient distance from the row to enable the operator to produce exactly parallel rows by driving with the tongue of the planter directly over the tiny furrow. The instrument was further improved, and brought to its present form by Jarvis Case, of Lafayette, Indiana, in 1857." \*\*\*\*\* "J.N. Vandiver in 1863 patented adjustable covering shares. \*\*\*\*\* An early patent of George W. Brown shows the principle of the rotary drop, in which the dropping plate is rotated by intermittent stops, moving forward with either a right or left motion of the dropping lever." (1, p.32)

In the latter part of the 19th century some manufacturers adopted "the principle of gearing the dropping mechanism to the wheel of the planter so as to drop one kernel at a time into the valve. The advantage of this device" \*\*\*\*\* "is that the corn can, if desired, be planted in hills with a check-row attachment or the check-rower can be taken off and the corn drilled in." \*\*\*\*\* Some other manufacturers "introduced what they termed a 'force feed' - a peculiar form of secondary drop operating in the valve of the planter." Another built its planters with "a telescoping axle, by which the wheels could be moved away from the rows when it was not considered best to pack the soil on the corn." About this time stool was generally adopted in the construction of corn planters." (1, p.32, 34)

### Check rowers

"The first invention of a planter to drop in check automatically, is accredited to M. Robbins, of Cincinnati, Ohio, whose patent of February 10, 1857, covered a reversible hopper, an arm with vibrating claw or tappet connected with the seeding mechanism, in combination with a jointed rod or chain provided with buttons. This patent was reissued February 9, 1858, with three claims, the first covering the dropping of seed from a plow or



drill by means of an anchored chain or its equivalent, the second claim covering the chain or cord, and the third claiming an arm with a vibrating claw, or tappet, or equivalent devices, operating the seed discharging mechanism. Mr. Robbins' invention was practically a one-horse drill, with the chain or rod attached as patented, and it did not become known as a 'check-rower'. This name was given to later inventions of the Haworths and others, who had in view a separate attachment to be put on any planter. (1, p.34)

Following the Robbins patent was one "issued to John Thompson and John Ramsay, of Alton, Illinois, September 29, 1864, and covered the employment or use of a wire or cord, provided with knots at a suitable distance apart, and applied to the machine \*\*\*\*\* with anchors. This was reissued as assigned to G.D., J.W., L.L. and M. Haworth, December 21, 1875, and again October 31, 1876. The last reissue covered the knotted cord for actuating seeding devices; guides or pulleys arranged to transfer said cord from one side of the machine to the other in its passage over the same; the combination with the rock shaft operated upon the cord, of forked arms or levers placed one at each end of said rock shaft and adapted to be operated upon alternately by the cord; and finally, the arrangement of seeding devices in connection with the cord, whereby the latter could impart positive movement in one direction to seeding devices." (1, p.34-35)

"April 24, 1866, W.W. Hubbard, of Edinburg, Indiana, obtained a patent for various improvements, which also was reissued to the Haworths, March 27, 1877. This covered horizontal traversing bars for automatically moving check-row cords at the end of the field, and a movable arm for supporting on machine when turning. G.D. Haworth took out a patent on check-rower devices February 22, 1870, and several others were issued later to the Haworths in the same line." (1, p.35)

"A patent was issued to Alden Barnes, of Bloomington, Illinois, November 5, 1872, and was reissued in two divisions, February 20, 1877, covering several devices, the most important being a check-row chain made with knots formed by coiling a piece of wire around the main wire. (1, p.35)

Crampton, (5, p.5) relates that "Alden Barnes on November 5, 1872, designed a check rower which operated at the side of the planter. This was improved upon in a patent to A. & M. Barnes, December 19, 1896. \*\*\*\*\* Other check rowers were also brought out and thus the drop seat passed out of existence, although it was used for a time to plant the cross rows at end of field."

#### Listers

"The introduction of the lister -- a modified form of corn planter -- dates from about 1880. Several patents were granted to Missouri and Kansas farmers, and the implements were at first made in small numbers by local blacksmiths." \*\*\*\*\* The distinguishing feature of a lister is a small double moldboard plow adapted to opening a furrow, (generally with a subsoiler running behind to make a seed-bed), in combination with a covering wheel, a seed-box and mechanism actuated by the covering wheel for dropping the corn. Sometimes a lister is mounted on two wheels like an old-fashioned



sulky plow, and still other forms and adaptations have been used." (1,p.34)

Wallace's Farmer, v.53, no. 18, May 4, 1928, p.31 is authority for the following quotation:- "The lister was first introduced in Kansas in 1882, and proved popular from the first. By 1902 three-fifths of Kansas corn land was listed. The early listers were all single row implements, and had an incomplete turn of the moldboard which scraped up a ridge rather than turning a well rounded furrow."

#### Recent developments

"C. H. and H. L. Dooley, of Bloomington, Illinois, devised a clutch, patented November 28, 1893, by means of which an exact number of cells could be passed under the cut-off between each hill and the next, and the planter became a counting as well as a planting machine. This patent was re-issued July 23, 1895. (5, p.5)

In the 1900 Census (11, p.360) appears the following statement: "A late style of corn-planter, embodying nearly all the approved devices, is a two-horse machine, constructed almost entirely of steel, with two seed-boxes, and check row, drill, and force-feed attachments for which are claimed absolute accuracy in dropping the seed, regularity in the number of seeds dropped, and adaptability to different inclinations of the soil, secured by a lever which forces the runners to work at equal depth under different conditions. This machine can also be adjusted to rows varying in width."

From 1900 to the present time (1935) no radical changes have been made in the general design of conventional 2-row horse-drawn corn planters. However, the planter has been greatly improved, strengthened and refined, and has reached a high degree of perfection and versatility. On modern corn planters the distance in drilling as well as the number of kernels per hill in hilling can be readily changed, the marker is automatically shifted in turning, and different kinds of runners and disk furrow openers as well as other attachments, can be readily mounted on the machine.

Attachments for distributing fertilizers simultaneously with the planting of the corn closely followed the development of successful planters. Until recent years these attachments were very simple, and the fertilizer was directed through a tube at the rear of the seed shoe into the seed furrow. The increased use of mineral fertilizers instead of organic materials during the past fifteen years, necessitated the separation of the fertilizer from the seed to avoid injury. Devices were developed for placing the fertilizer only at the hills of corn, and to give some separation of seed and fertilizer. A reasonably successful type of fertilizer depositor, consisting of a boot with valve and divider covered by a hood, was placed on the market in 1929. With this device the fertilizer is deposited at each side of the row, either in continuous bands or in short bands at the hills.

With the introduction on the market in 1924 of the general purpose or row crop tractor, four-row corn planters were used. The first planters of this type consisted of two horse-drawn machines held together by a suitable hitch, and were pulled by the tractor. Numerous developments followed rapidly



and at the present time two-and four-row corn planting units for tractors are on the market. Both power-lift planters for mounting on the tractor, and units to be pulled by the tractor, are available. The necessary soil working tools are available for use with tractor planters to permit planting on ridges, on level land, or in list furrows. Some of the most recent tractor planting attachments have individual floating units for accurately drilling corn on uneven or terraced land, and are equipped to place the fertilizer in a band at the side of the row.

Corn planters are now built in a number of different types and sizes of machines, to meet the varied requirements and conditions. Interchangeable seed plates are available for planting seed of numerous kinds of crops. Some planters are equipped with hoppers or attachments to permit planting peas or other seed at the time of planting corn. Furrow openers are also available for planting seed at a variable depth to provide greater assurance of a stand of plants under adverse conditions, particularly for crops which are thinned after the plants come up.



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FARM MACHINES, OLD AND NEW, IN PICTURES:

FOR CORN PLANTING



## FOR CORN PLANTING

Figure 1.- Planting or dropping corn by hand.

Figure 2.- A hand corn planter, an improvement over hand dropping.

Figure 3.- A horse-drawn corn planter of a type used in the United States about the middle of the 19th century.

Figure 4.- An early check-row corn planter of between 1850 and 1860. The field was first marked off, and, in planting, the dropping mechanism was tripped by hand at intersections with the transverse marks.

Figure 5.- A two-row, check-row corn planter in which a wire with regularly spaced obstructions is used for tripping the planting mechanism. A patent was granted on this type of planter in 1857.

Figure 6.- A modern four-row corn planter mounted on a tractor.



